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# BRUCE GS 'B'
# PREOPERATIONAL BIOLOGICAL STUDY
# YEAR I - 1979

Report No 83-182-K

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## ABSTRACT

The results of a preoperational biological study at Bruce GS 'B' in 1979 are presented. Station construction was underway during the sampling period. Sedimentation was highest during the fall south of the construction site. Water temperatures were virtually isothermal on all sampling dates. Little variation was evident in water quality parameters. Sediment heavy metal concentrations were generally greater in August than in November. Phytoplankton and zooplankton distribution did not appear to be related to temperature nor were consistent distribution trends apparent. Attached algae exhibited spatial and temporal variation with low biomass values. No consistent trends were apparent with depth or transect location in macroinvertebrate richness or diversity. Alewife, longnose sucker, lake chub and white sucker dominated the adult and juvenile fish community. Alewife and smelt dominated the larval fish community. Significant variation was apparent in adult and juvenile fish densities with depth and transect location.

| job | file | date | report no. |
|---|---|---|---|
| 740634-120-00 | 837.321BRU | April 25, 1983 | 83-182-K |

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ontario hydro
research division

To Dr. W.R. Effer
Manager - Environmental
Studies and Assessments
Design and Development Division

# BRUCE GS 'B' PREOPERATIONAL BIOLOGICAL STUDY
## YEAR I - 1979

## 1.0 INTRODUCTION

The first of three years of preoperational biological study at Bruce GS 'B' was completed in 1979 at the request of Environmental Studies and Assessments, Design and Development Division. The objective of the preoperational aquatic survey is to define the physical, chemical and biological characteristics of the inshore aquatic environment in the vicinity of the Bruce GS 'B'. The collected data will provide the background information required for measurement of potential future effects of plant operation on the nearshore aquatic environment at the Bruce GS 'B' site.

This report presents data collected during the 1979 survey. A detailed comparison of Bruce GS 'B' preoperational biological data will be presented in a 3-year summary report.

Construction work at the Bruce GS 'B' site commenced prior to the 1979 preoperational study. Two kilometres of shoreline were altered with the addition of armour stone from South Boundary Road in the south to Lagoon Bay in the north. The Bruce GS 'B' intake, Bruce GS 'B' discharge and Lagoon Bay sampling transects were located in the modified area. The BNPD sewage lagoon located on the Bruce GS 'B' site was filled in prior to the 1979 study.

Plant construction activities continued throughout the 1979 survey. Two discharge groins were extended into Lake Huron. The discharge channel was then opened to the lake and deepened by underwater demolition.

## 2.0 METHODS

### 2.1 Site Description

The Bruce GS 'B' site is located on the eastern shore of Lake Huron approximately 18 km north of Kincardine. The study area and sampling locations are presented in Figures 2.1-1, 2.1-2 and 2.1-3. Sampling was concentrated on seven transects,

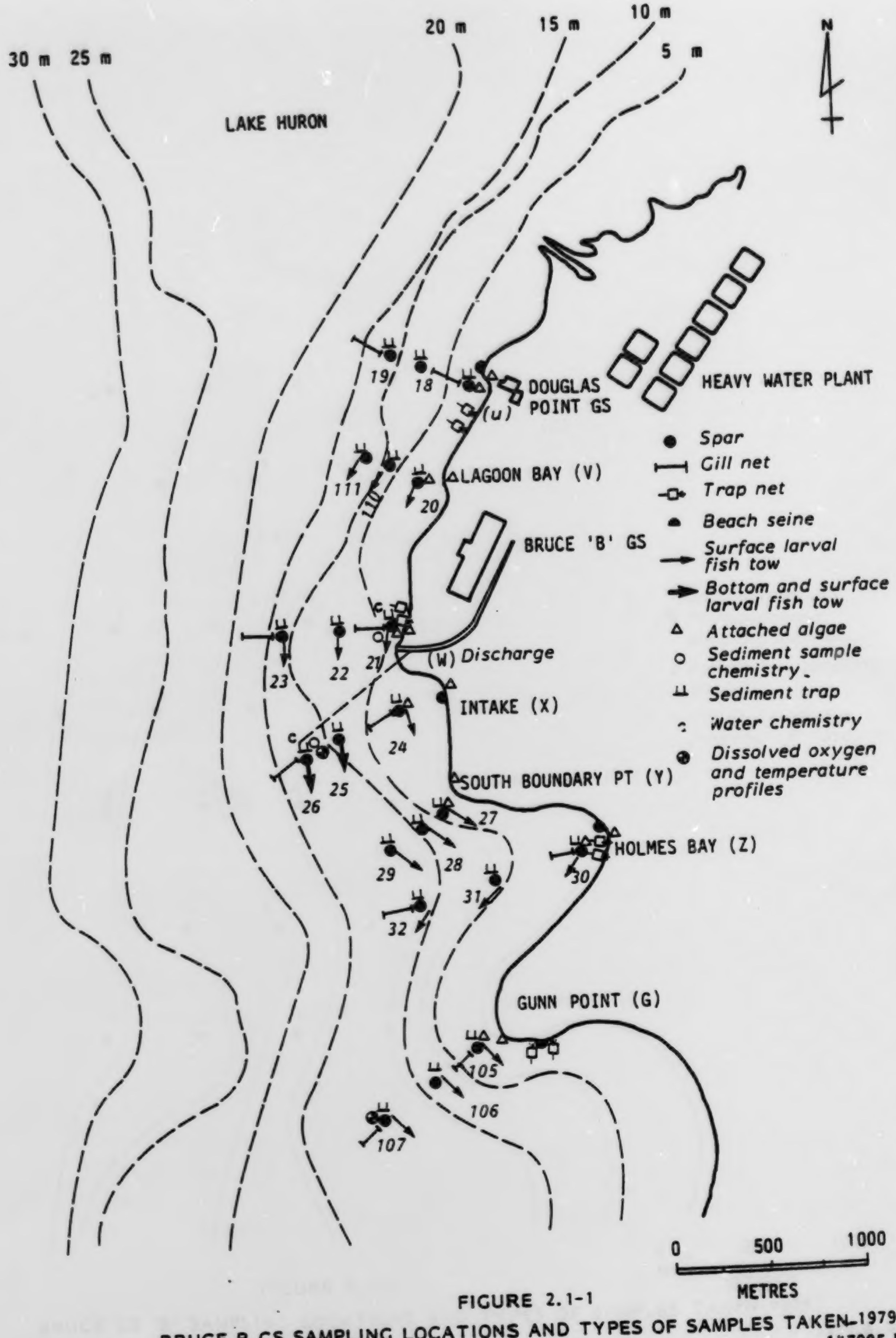

30 m
25 m
20 m
15 m
10 m
5 m
N
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
(u)
LAGOON BAY (V)
BRUCE 'B' GS
(W) Discharge
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
19
18
111
20
23
22
21
24
25
26
27
28
29
30
31
32
105
106
107
c
Spar
Gill net
Trap net
Beach seine
Surface larval fish tow
Bottom and surface larval fish tow
Attached algae
Sediment sample chemistry
Sediment trap
Water chemistry
Dissolved oxygen and temperature profiles
0
500
1000
METRES

FIGURE 2.1-1

BRUCE B GS SAMPLING LOCATIONS AND TYPES OF SAMPLES TAKEN-1979

147905 RD

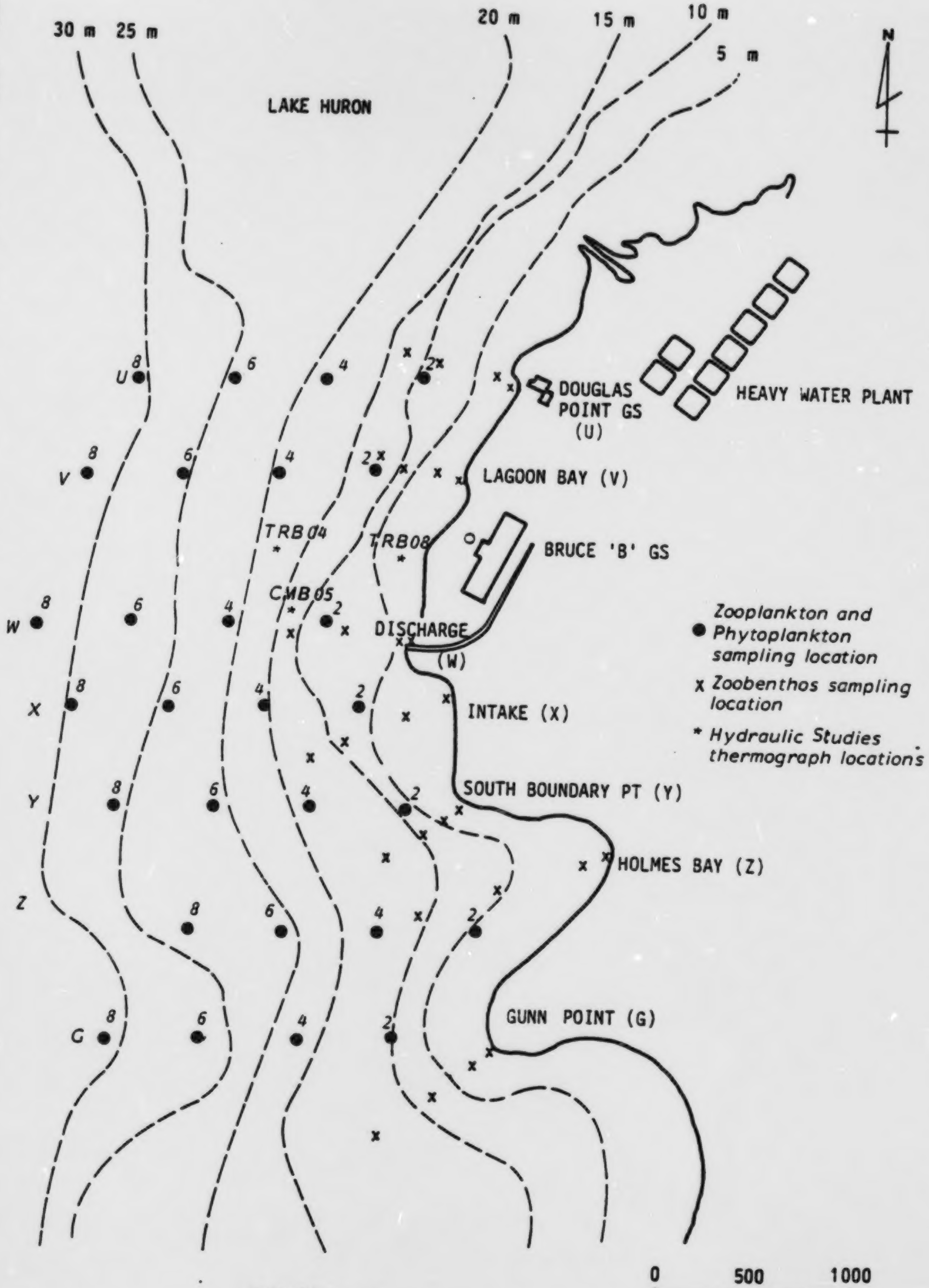

30 m
25 m
20 m
15 m
10 m
5 m
N
LAKE HURON
U
V
W
X
Y
Z
G
8
6
4
2
TRB04
TRB08
CMB05
DOUGLAS POINT GS (U)
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE (W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
● Zooplankton and Phytoplankton sampling location
x Zoobenthos sampling location
* Hydraulic Studies thermograph locations
0
500
1000
METRES

FIGURE 2.1-2

BRUCE GS 'B' SAMPLING LOCATIONS AND TYPES OF SAMPLES TAKEN-1979

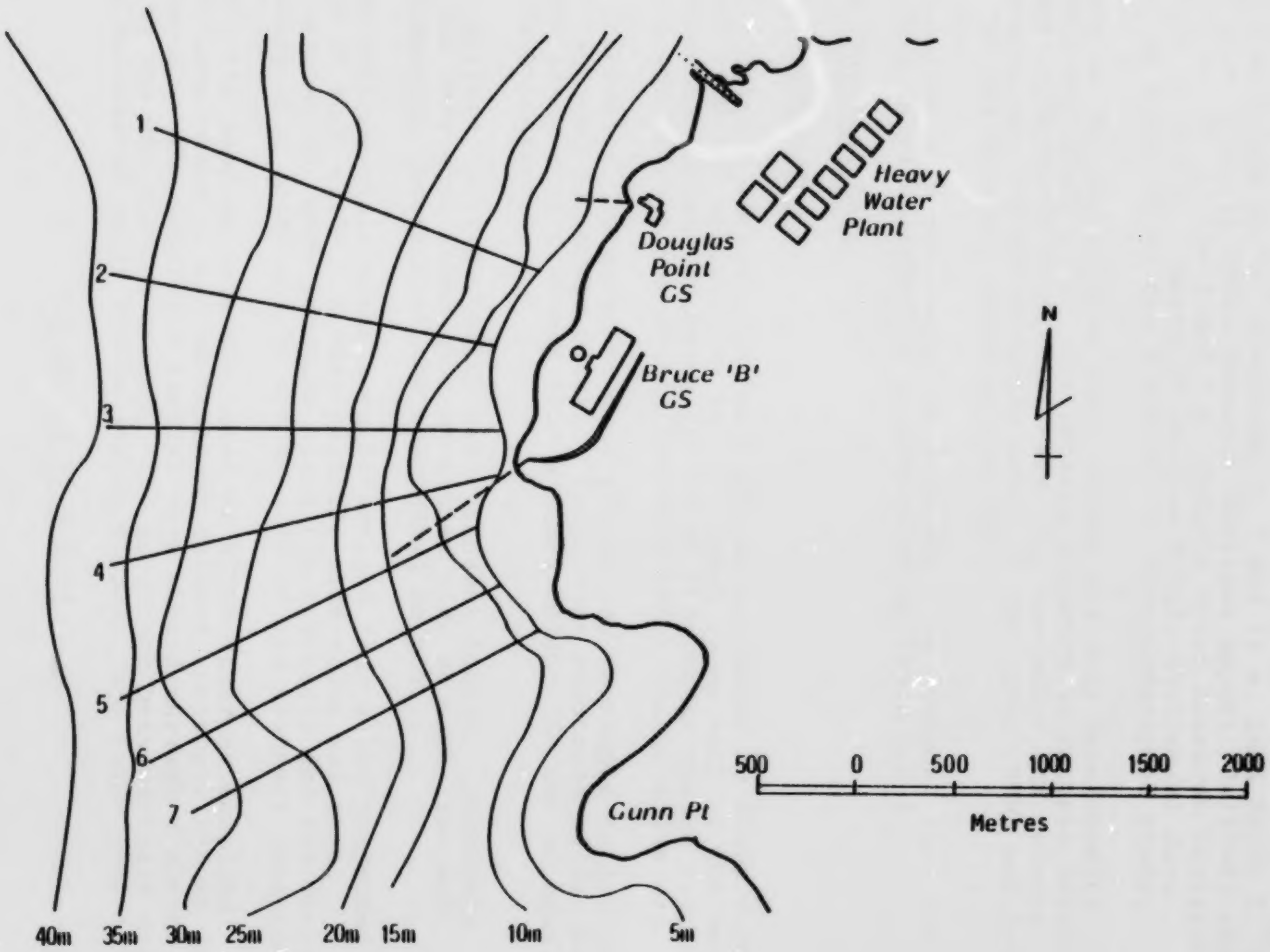

Heavy
Water
Plant
Douglas
Point
GS
Bruce 'B'
GS
N
Gunn Pt
500
0
500
1000
1500
2000
Metres
1
2
3
4
5
6
7
40m
35m
30m
25m
20m
15m
10m
5m

FIGURE 2.1-3

LOCATION OF ACOUSTIC TRANSECTS AT BRUCE GS 'B' - 1979 spaced approximately 500 m apart from Douglas Point to Gunn Point. The intake location for Bruce GS 'B' is on transect X, at about the 12 m depth contour. The study site duplicates Bruce GS 'A' survey spars at Douglas Point 3, 7 and 12 m, Lagoon Bay 3 m, Bruce GS 'B' discharge 3, 7 and 12 m, Gunn Point 3, 7 and 12 m (Ontario Hydro Research Division Report 77-167-K) and Bruce GS 'B' intake 3 and 7 m (Ontario Hydro Research Division Report 75-323-H). North of Douglas Point, biological data will be provided by the Bruce GS 'A' Postoperational Study.

Bruce GS 'B' and Douglas Point GS are the only developments within the study site. The Ontario Ministry of Natural Resources (OMNR) Inverhuron Provincial Park (day use only) and private cottages are located directly south of the site. BHWP and Bruce GS 'A' are directly north of the site.

The survey work was conducted from May 1 to November 21. The monthly sampling schedule is presented in Table 2.1-1.

## 2.2 Physical Data

### 2.2.1 Substrate

The substrate composition was visually estimated by SCUBA diver towed from the splash zone to 12 m depth along each of the seven transects. These estimates indicated that Ponar dredge sampling would not provide the detail required for a quantitative map.

An underwater photographic grid system was developed to provide the required substrate detail. Triplicate substrate slides were taken along each transect from a fixed height (84 cm) at equal surface intervals.

The surface interval varied with transect length. Substrate slides were also taken 10 m on either side of each transect photography location at the same fixed height.

Substrate particle sizes were determined from a 20% projected area of each slide. A mean particle size value was then determined for each location along the transects and the corresponding 10 m locations on either side of the transect location.

Substrate samples were collected by SCUBA diver at sampling locations where it was possible to collect substrate <40 mm in diameter. The substrate samples were sieved through 8 sieves using the wet sieving method. The substrate mean particle size was calculated using the following formula from Folk (1968):

$$\frac{\phi\,16 + \phi\,50 + \phi\,84}{3} = \phi$$

The calculated phi value was converted to millimetres.

## Table 2.1-1

### Monthly Sampling Schedule Bruce GS 'B' - 1979

| Samples | Collection Date • | | | | | | |
|---|---|---|---|---|---|---|---|
| | M | J | J | A | S | O | N |
| Substrate - map | | | X | X | X | | |
| Sediment Traps | X | ---- | ---- | X | ---- | ---- | X |
| Temperature, Dissolved Oxygen, Transparency | X | X | X | X | X | X | X |
| Water Chemistry | | X | | X | | X | |
| Sediment - Trap Chemistry | | | | X | | | X |
| Sediment Sample Chemistry | | | | X | | | |
| Phytoplankton & Zooplankton grids | | X | | X | | X | |
| Attached Algae | | X | | X | | X | |
| Zoobenthos | | X | | | | X | |
| Ichthyoplankton | X | XX | XX | XX | | | |
| Adult & Juvenile Fish | X | X | X | X | X | X | X |
| Acoustic Fish Census | | X | | X | | X | |

The substrate samples were oven dried at 105°C for 24 hours and then ashed at 525°C for 2 hours in order to determine the substrate organic content.

### 2.2.2 Sedimentation

Sediment traps were set at the 3, 7 and 12 m depths along each of the seven transects in May (Figure 2.1-1). The traps consisted of four PVC tubes, 63 cm high with an inside diameter of 5 cm vertically supported on metal stands. The lower end of each tube was capped. SCUBA divers capped, retrieved and replaced the tubes in August. The tubes were capped and removed in November. Retrieved tube contents were preserved in 10% formalin. The contents of each tube were allowed to settle for one hour, oven dried at 105°C to a constant weight and then ashed at 525°C for two hours.

### 2.2.3 Temperature and Dissolved Oxygen and Transparency

Temperature and dissolved oxygen profiles were collected at 1 m intervals monthly from May to November at Bruce GS 'B' intake 12 m and Gunn Point 12 m. A Hydrolab TDO-2 meter was utilized for the determinations. Secchi disc readings were recorded at the same locations on the same dates.

Hydraulic Studies and Development Department recorded water temperature profiles at three Bruce GS 'B' intake locations and depths (Figure 2.1-2). Temperatures were recorded at depths of 2.5, 14.0 and 20.0 m at THB08, CMB-5 and THB04, respectively.

## 2.3 Chemical Characteristics

### 2.3.1 Water Chemistry

Water quality samples were collected in a PVC Van Dorn sampler in June, August and October. Surface and bottom samples were collected at the Bruce GS 'B' intake 12 m spar. Surface samples were collected at the Bruce GS 'B' discharge 3 m spar. The samples were preserved and stored according to the guidelines in Ontario Hydro Research Division Report 78-285-K.

Analytical Services Section of the Chemical Research Department analyzed the samples. The parameters analyzed are listed in Table 2.3.1-1.

### 2.3.2 Sediment Trap - Sediment Chemistry

Subsamples of the sediment collected in tubes at the 7 m depths at Douglas Point, Bruce GS 'B' discharge, South Boundary Point and Gunn Point were analyzed for the heavy metals listed in Table 2.3.2-1. The samples were collected in August and November. Heavy metal analysis was performed by Analytical Services Section of the Chemical Research Department (Ontario Hydro Research Division Report 80-377-K).

## Table 2.3.1-1

## WATER CHEMISTRY ANALYSIS
## BRUCE GS 'B' - 1979

### Analysis

pH
Conductivity (mS/m)
Turbidity (NTU)
Colour
Suspended Solids at 105°C (mg/L)
Suspended Solids at 550°C (mg/L)
Dissolved Solids at 105°C (mg/L)
Dissolved Solids at 550°C (mg/L)
Alkalinity (mg/L as $CaCO_3$)
Hardness (mg/L as $CaCO_3$)
Total Phosphorus (mg/L)
Orthophosphorus (mg/L)
Total Nitrogen (mg/L)
Soluble Nitrogen (mg/L)
Nitrite (mg/L as $NO_2$)
Nitrate (mg/L as $NO_3$)
Kjeldahl Nitrogen (mg/L)
Particulate Nitrogen
Ammonia (μg/L)
Chloride (mg/L)
COD (mg/L as COD)
Sulphate (mg/L)
TOC (mg/L as C)
Chlorophyll a (ug/L)
Phaeophytin
Al (mg/L)
Ca (mg/L)
Fe Total (mg/L)
Fe Dissolved (mg/L)
K (mg/L)
Mg (mg/L)
Na (mg/L)
Si Total (mg/L as $SiO_2$)
Si Dissolved (mg/L as $SiO_2$)

## Table 2.3.2-1

## Sediment Trap - Sediment Chemistry Analysis
(mg/kg - dry basis)

## BRUCE GS 'B' - 1979

### Analysis

Aluminum
Arsenic
Barium
Beryllium
Bromine
Calcium
Cadmium
Cerium
Chlorine
Cobalt
Chromium
Cesium
Copper
Dysprosium
Europium
Iron
Hafnium
Mercury
Iodine
Potassium
Lanthanum
Lutetium
Manganese
Sodium
Nickel
Lead
Rubidium
Antimony
Scandium
Selenium
Samarium
Strontium
Tantalum
Terbium
Thorium
Titanium
Uranium
Vanadium
Ytterbium
Zinc

### 2.3.3 Sediment Sample Chemistry

Substrate samples for heavy metal analysis were collected by SCUBA diver in August and September at Bruce GS 'B' intake 12 m and Bruce GS 'B' discharge 3 m. The August samples were collected concurrent with the August water quality samples. The samples were submitted to Analytical Services Section for heavy metal analysis (Table 2.3.2-1).

## 2.4 Biological Characteristics

### 2.4.1 Phytoplankton and Zooplankton

Phytoplankton and zooplankton samples were collected at twenty-eight surface grid sampling locations (Figure 2.1-2) in June, August and September. The sampling locations were set 500, 1000, 1500 and 2000 m from shore along each of the seven Bruce GS 'B' transects creating a 7 x 4 matrix grid. Integrated phytoplankton samples were collected with a 3 m PVC tube. Samples were preserved in Lugol's iodine. The samples were concentrated five times by settling and identified at 300 magnification on a Wild M40 microscope. The species were enumerated and the counts converted to biomass measurements.

Zooplankton samples were collected coincident with phytoplankton sampling. A 27 L Schindler-Patalas zooplankton trap with a 64 $\mu$ mesh straining bucket was used. The samples were immediately preserved in 95% ethanol. Laboratory analyses included identification, enumeration and calculation of numbers/$m^3$.

Phytoplankton and zooplankton data were subjected to Mutual Information Analysis in an attempt to identify assemblage distribution patterns.

Surface dissolved oxygen and water temperatures as well as Secchi disc measurements were made at each sampling location.

### 2.4.2 Attached Algae

Triplicate 25 $cm^2$ attached algae samples were collected from rock surfaces along the shoreline and at 3 m depths on the seven transects (Figure 2.1-1). Samples were collected in June, August and October and were preserved in 10% formalin. Shoreline surface temperatures and bottom temperatures at the 3 m spars were recorded.

Each sample was examined for species composition. Biomass was expressed as ash-free dry weight (gm/$m^2$) following 24 hour drying at 105°C and ashing at 525°.

### 2.4.3 Zoobenthos

Triplicate zoobenthos samples were collected along seven transects at 1, 3, 7 and 12 m depths in late June and October (Figure 2.1-2). Each sample was collected from a 107.5 $cm^2$ scraped sampling area with a dome sampler and slurp gun operated by SCUBA divers. The samples were preserved in 5% formalin. At each sampling location the substrate particle size and per cent coverage by attached algae were estimated. Water temperature and dissolved oxygen were recorded approximately 1 m above the substrate at each sampling point. Secchi disc readings were taken at each sampling location. Samples were identified to species when possible. Results were presented as number/$m^2$.

### 2.4.4 Ichthyoplankton

Larval fish were collected along the six transects from Lagoon Bay to Gunn Point at the 3, 7 and 12 m spar locations (Figure 2.1-1). Sampling began in mid May and continued biweekly until late August. Five minute surface tows were performed parallel to shore at each site using two 0.5 m diameter conical nets with 361 μ mesh. The tows began at dusk and continued during the night to completion.

Five minute bottom tows were performed at the 7 m (Spar 25) and 12 m (Spar 26) depth contours on the Bruce GS 'B' intake transect. The bottom tows were conducted on the same date as the surface tows using the same nets.

All of the samples were preserved in 10% formalin. Samples were sorted and where possible, specimens were identified to species. The total length and weight was determined for a maximum of ten fish of each species per sample.

### 2.4.5 Adult and Juvenile Fish

Three types of fishing gear were used to gather data on fish species at the Bruce GS 'B' site (Figure 2.1-1).

#### Gill Nets

Two consecutive 24-hour experimental gill net sets were made at the 3 m and 12 m depths at Douglas Point, Bruce GS 'B' discharge, Bruce GS 'B' intake, Holmes Bay and Gunn Point. The gill nets were set perpendicular to shore beginning at the 3 m and 12 m depths respectively. The gill nets were constructed of eight 15 m (50 ft) panels with stretched mesh sizes ranging from 3.8 cm (1.5 inches) to 12.7 cm (5.0 inches) in 1.27 cm (0.5 inches) intervals. The gill netting program was conducted monthly from May to November.

### Trap Nets

Two 1.2 m (4 ft) trap nets were set for two consecutive 24-hour periods at Douglas Point, Bruce GS 'B' discharge, Holmes Bay and Gunn Point. The nets were set monthly from May to October coincident with gill net samplings.

### Beach Seines

Duplicate 15 m beach seines were collected monthly from May to October at Douglas Point, Bruce GS 'B' intake, Holmes Bay and Gunn Point during the gill netting period. The proposed beach seines at the Bruce 'B' discharge were deleted because a suitable beach seining site was not available. All beach seines commenced at dusk and continued into the evening until completed.

Either all of the fish collected or a selected sample and random sample combination were preserved in 10% formalin. The fish were then speciated, counted and a species subsample weighed and measured.

A maximum of 100 fish from each of the three dominant fish species collected in all gear types were to be weighed and fork length measurements taken.

Stomach contents of six fish species captured in gill nets and trap nets were collected and preserved in 10% formalin. The stomach contents were identified and quantified in the laboratory.

### 2.4.6 Acoustic Fish Census

Nearshore fish distribution and abundance in the Bruce GS 'B' study area was determined by Acoustic Fish Census at depths of 4 to 40 m. The acoustic fish census was conducted during the day and night on June 6 and October 30 and during the day on August 30. Equipment failure prevented an August 30 night census.

The acoustic fish census system, as described in Research Division Reports C78-157-K and 80-197-K, consisted of a high resolution echo sounder interfaced with an echo analysis logic and magnetic tape recorder. This allowed automatic sorting and counting of echoes by amplitude and location, with data logging at specified intervals, with verification provided by a separate high-resolution graphic record. Boat speed (3 m/s), depth sorting (6 m intervals), and the length of data logging intervals (30 sec) were such that individual data cells represented a section of the water column 6 m in depth and approximately 100 m in length. Additional information of survey methods and data acquisition is given in Research Division Reports 79-363-K and C79-87-K.

Echo data were converted to densities per volume (No/10 000 $m^3$) and densities per area (No/10 000 $m^2$ = No/hectare) to allow description of vertical and horizontal distributions respectively.

Identification of fish species responsible for observed echoes was based on short-term gill netting carried on coincident with the acoustic survey as well as 24-hour gill netting carried out within the regular fishing program. Additional information was provided by the aggregation patterns observed on the graphic record.

Gill nets set coincident with the acoustic survey were set inshore and offshore along portions of the middle transect (4). Surface and bottom sets were made inshore, and bottom sets offshore. Each net consisted of eight 15 m (50') panels ranging from 2.5 cm (1") to 11.4 cm (4-1/2") in mesh size. All nets were deployed perpendicular to shore, and set for 3 to 5 hours.

Data on the horizontal and vertical temperature structure was obtained for possible correlation with fish distribution. Temperatures at 0.5 m were monitored continuously during the conduct of the acoustic survey, while vertical temperature profiles were obtained at 200 m intervals along transect 4.

## 3.0 RESULTS AND DISCUSSION

### 3.1 Physical Characteristics

### 3.1.1 Substrate

The Bruce GS 'B' substrate is depicted in Figure 3.1.1-1. The figure is an expansion of the mean site substrate composition (Appendix A) derived from substrate slide interpretation results (Appendix B).

The substrate composition at spar locations was predominantly bedrock (42%) with cobble (24%), boulder (14%) and pebble (14%) (Figure 3.1.1-1). Silt (2%), sand (2%) and gravel (2%) were present in small quantities.

Bedrock, boulder, cobble, pebble and gravel were found in varying proportions at the 3, 7 and 12 m sampling sites (Figure 3.1.1-2). Sand was located only at the 3 m sampling site. Silt was present only at the 7 m sampling locations.

Bedrock was the major substrate component at the 3 m depths. It comprised 65% of the substrate. Cobble (11%) and sand (10%) were the next major substrate components. Silt (0%) was absent from the 3 m sampling depth.

Boulder (32%) and cobble (31%) were the dominant substrate types at the 7 m sampling locations. The pebble component at 7 m increased to 17% from 7% at 3 m. Bedrock composition declined to 10%. Silt (7%) and gravel (<1%) were present in small amounts while sand was absent (0%).

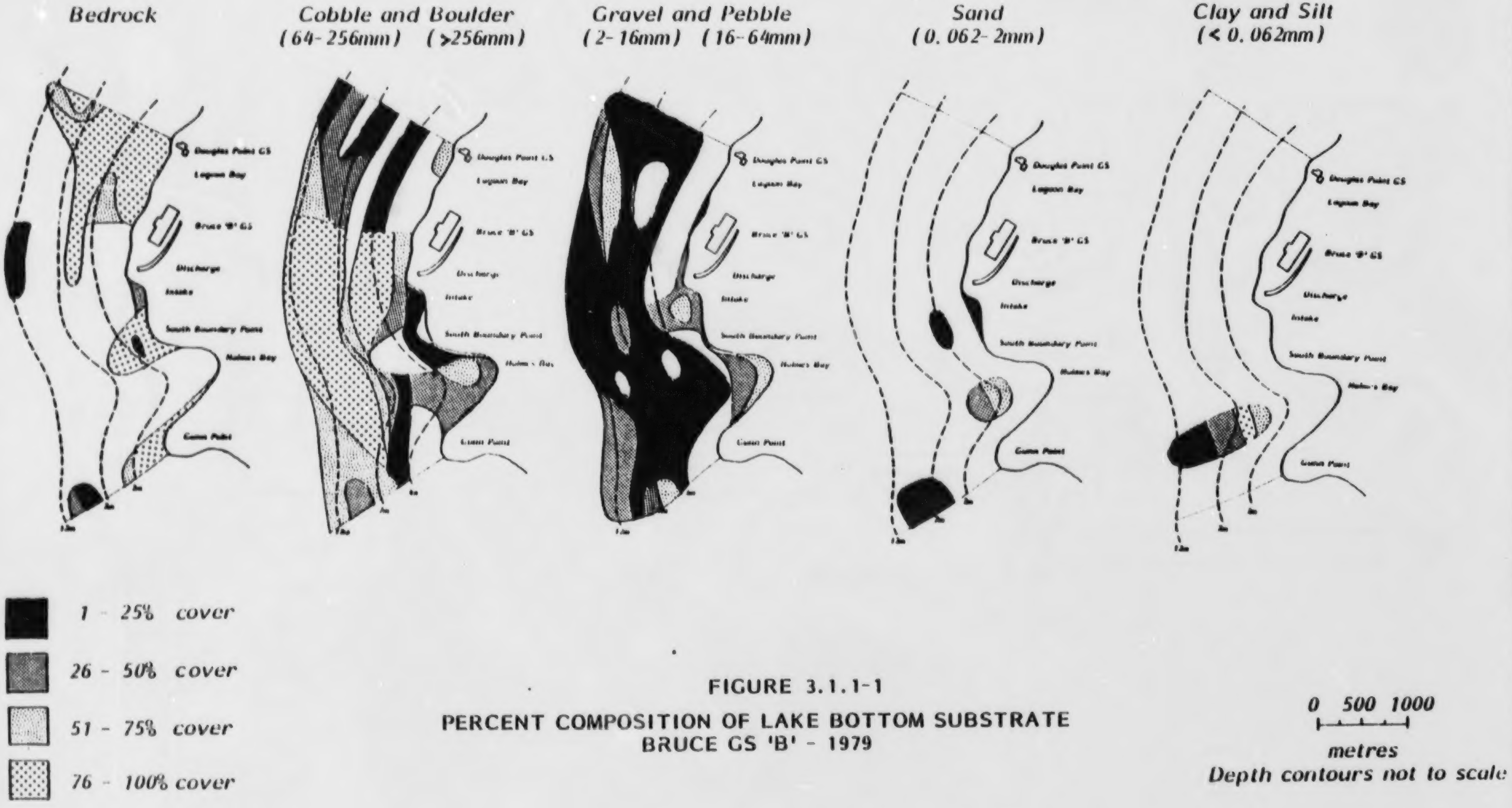

Bedrock
Cobble and Boulder
(64-256mm) (>256mm)
Gravel and Pebble
(2-16mm) (16-64mm)
Sand
(0.062-2mm)
Clay and Silt
(< 0.062mm)
Douglas Point GS
Lagoon Bay
Bruce 'B' GS
Discharge
Intake
South Boundary Point
Holmes Bay
Gunn Point
1 - 25% cover
26 - 50% cover
51 - 75% cover
76 - 100% cover
0 500 1000
metres
Depth contours not to scale

FIGURE 3.1.1-1

PERCENT COMPOSITION OF LAKE BOTTOM SUBSTRATE
BRUCE GS 'B' - 1979

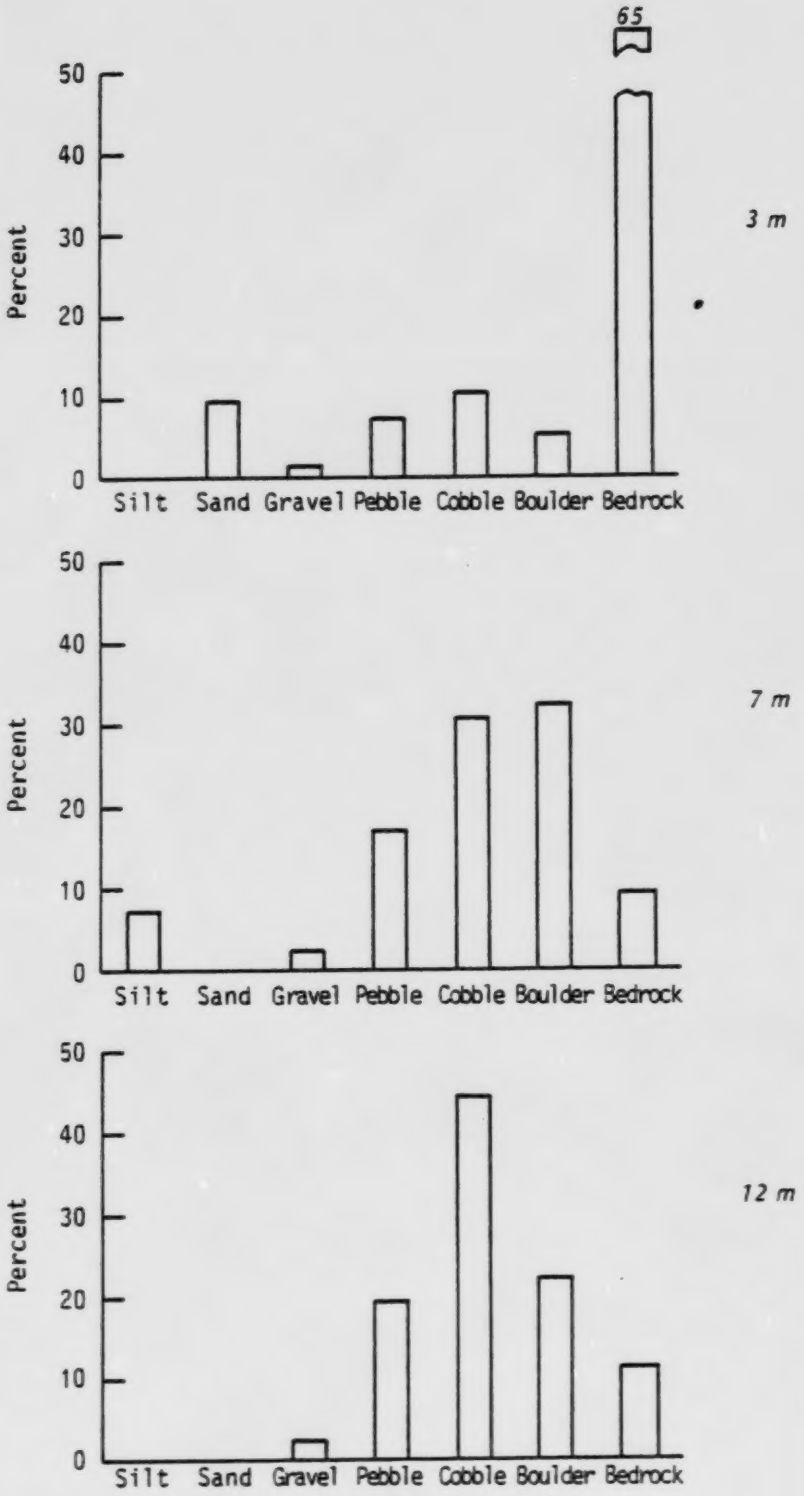


FIGURE 3.1.1-2

PER CENT COMPOSITION OF LAKE BOTTOM SUBSTRATE
ALONG DEPTH CONTOURS
BRUCE GS 'B' - 1979

Cobble was the major substrate type at 12 m comprising 45% of the substrate. Boulder (22%), pebble (19%), bedrock (11%) and gravel (3%) were also present. Silt (0%) and sand (0%) were absent.

Bedrock was the major substrate component at Douglas Point (Figure 3.1.1-1). The substrate at the 2, 4 and 9 m depths was 100% bedrock. Bedrock comprised over 50% of the substrate at all other Douglas Point sampling sites.

South of Douglas Point bedrock was replaced by cobble and boulder overburden between 7 and 12 m at Lagoon Bay. However, bedrock composed over 70% of the substrate at depths shallower than 7 m along the Lagoon Bay transect.

At the Bruce GS 'B' discharge 100% bedrock was present at 6 m. Cobble (5 m) and boulder (3 m) were dominant at shallower depths. Boulders were dominant at 7 m while cobble was dominant at 12 m.

Boulder and cobble were the dominant substrate components between 5 and 12 m at the Bruce GS 'B' intake. At 3 m cobble formed 50% of the substrate. Pebble and gravel comprised 44% of the 3 m substrate and 64% of the 2 m intake substrate.

At South Boundary bedrock was dominant between 3 and 5 m. Boulders and cobbles were the major substrate types along the transect from 7 to 12 m.

In the Holmes Bay area, cobble was the major substrate component at depths from 8 to 12 m. Silt was prevalent from 5 to 7 m while cobble was dominant at 4 m. The major substrate types at 3, 2 and 1 m were sand, boulder and cobble, and pebble and gravel respectively.

Bedrock was the exclusive substrate component inshore at Gunn Point from 1 to 3 m and the major component at 4 m. Cobble and boulder and gravel and pebble were the major substrate types between 5 and 9 m and at 12 m. A bedrock outcropping was found at 9 to 10 m.

## Substrate Particle Size Analysis

Samples for particle size analysis were collected at eleven locations on the Bruce GS 'B' site. Large substrate particle size (>16 mm) precluded collection of samples at the other seventeen sampling locations. No particle size samples were collected along either the Douglas Point or Lagoon Bay transects. The substrate particle size data is presented in Appendix C. The graphic means and the per cent organic content of the samples are presented in Table 3.1.1-1.

## Table 3.1.1-1

## GRAPHIC MEAN (mm) AND ORGANIC CONTENT (%) OF PARTICLE SIZE SAMPLES

## BRUCE GS 'B' - 1979

| Location | Depth m | Graphic Mean ±1 sd * mm | Organic Content % |
|---|---|---|---|
| Bruce 'B' discharge | 3 m | 5.54 (2.10-14.62) | 2.00 |
| | 7 m | 20.00 (13.64-29.24) | 5.23 |
| Bruce 'B' intake | 1 m | 0.04 (0.03-0.04) | 4.07 |
| | 3 m | 17.50 (9.06-33.82) | 4.33 |
| | 7 m | 18.80 (10.78-19.84) | 2.28 |
| South Boundary | 12 m | 23.80 (16.45-34.30) | 2.74 |
| Holmes Bay | 1 m | 20.20 (12.30-34.78) | 3.26 |
| | 3 m | 0.5 (0.37-0.60) | 1.46 |
| | 7 m | 0.34 (0.24-0.48) | 0.75 |
| | 12 m | 23.40 (16.0-34.30) | 4.49 |
| Gunn Point | 12 m | 18.0 (9.65-19.16) | 2.827 |

* Range in which 68% of the particles occur (mm)

The sediment sample graphic means ranged between 0.04 and 23.8 mm. Most of the substrate particles analyzed were in the 2.0 to 31.5 mm range. The maximum graphic means were determined at South Boundary 12 m (23.8 mm), Holmes Bay 12 m (23.4 mm) and Holmes Bay 1 m (20.2 mm). The smallest graphic means were determined at Bruce 'B' intake 1 m (0.04 mm), Holmes Bay 7 m (0.03 mm) and Holmes Bay 3 m (0.5 mm). Mean Bruce GS 'B' intake particle size increased from 0.04 mm (1 m) to 17.5 and 18.8 mm at 3 and 7 m respectively.

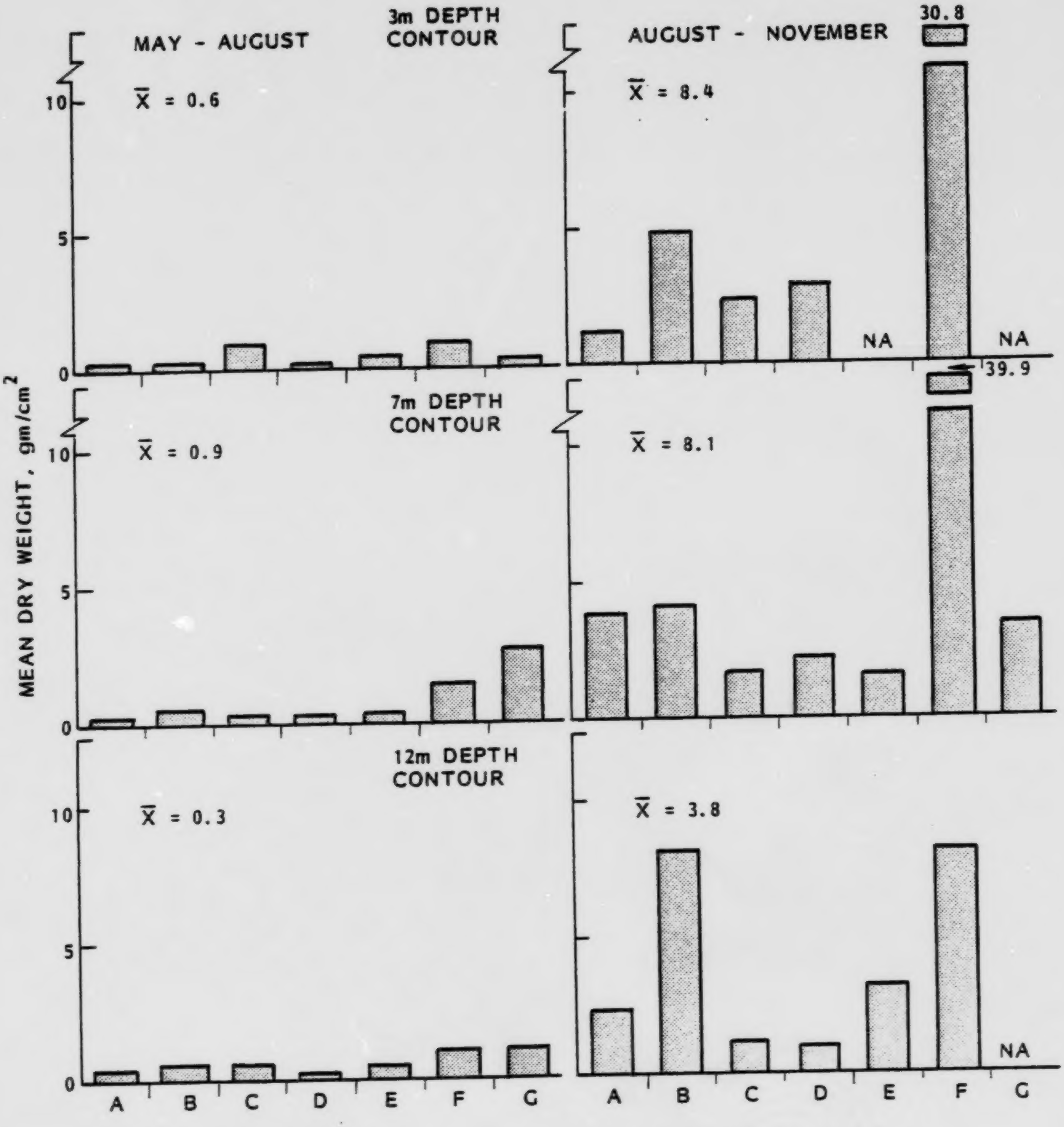
The organic content of the substrate samples ranged between 0.75% at Holmes Bay 7 m and 5.23% at Bruce GS 'B' discharge 7 m. No relationships were discernable between organic content and depth or organic content and sample site. The very low organic content values are related to the low productivity of Lake Huron.

### 3.1.2 Sedimentation

The total, inorganic and organic sedimentation data collected at the Bruce GS 'B' site from May to August (85 days) and August to November (85 days) are presented in Appendices D and E. Sediment tubes were not recovered at South Boundary 3 m and Gunn Point 3 and 12 m.

Generally the rate of sediment accumulation was higher during the August-November sampling period (1.0 - 39.4 $gm/cm^2$) than during the May-August period (0.1 - 2.7 $gm/cm^2$) (Figure 3.1.2-1). The rate of inorganic sediment accumulation was also higher in the August-November period (1.0 - 38.3 $gm/cm^2$) than in the May-August period (0.1 - 2.7 $gm/cm^2$) (Figure 3.1.2-2). Organic sediment accumulation followed the same general pattern with rates ranging from 0.07 - 1.33 $gm/cm^2$ in August-November and 0.01 - 0.07 $gm/cm^2$ in May-August (Figure 3.1.2-3). The higher August-November sedimentation values were probably the result of the higher wind occurrence and velocity and the associated higher wave activity experienced during the fall sampling period.

Along depth contours the sediment accumulation rate generally increased from the 3 m depth contour ($\bar{x}$ = 0.6 $gm/cm^2$) to 7 m ($\bar{x}$ = 0.9 $gm/cm^2$) and then decreased to the 12 m depth contour ($\bar{x}$ = 0.3 $gm/cm^2$) during the May-August sampling period. Exceptions to this pattern were evident at South Boundary 3 m (0.5 $gm/cm^2$) and 7 m (0.4 $gm/cm^2$) and at Lagoon Bay 7 m (0.5 $gm/cm^2$) and 12 m (0.6 $gm/cm^2$). No distinct pattern was evident in the accumulation of inorganic sediment along the 3 m (0.3 - 0.9 $gm/cm^2$) and 7 m (0.2 - 2.7 $gm/cm^2$) depth contours during May-August. Inorganic sediment accumulation at 12 m was usually less than at either the 3 or 7 m depth contours. The only exception to this pattern occurred along the Lagoon Bay transect where the inorganic sedimentation was the same at 7 and 12 m (0.5 $gm/cm^2$).



A DOUGLAS POINT
B LAGOON BAY
C BRUCE 'B' DISCHARGE
D BRUCE 'B' INTAKE
E SOUTH BOUNDARY POINT
F HOLMES BAY
G GUNN POINT
NA NOT AVAILABLE

FIGURE 3.1.2-1

TOTAL SEDIMENT (gm/cm$^2$) COLLECTED AT 3, 7 AND 12 METRE SPARS FROM MAY TO AUGUST AND AUGUST TO NOVEMBER 1979
BRUCE GS 'B'

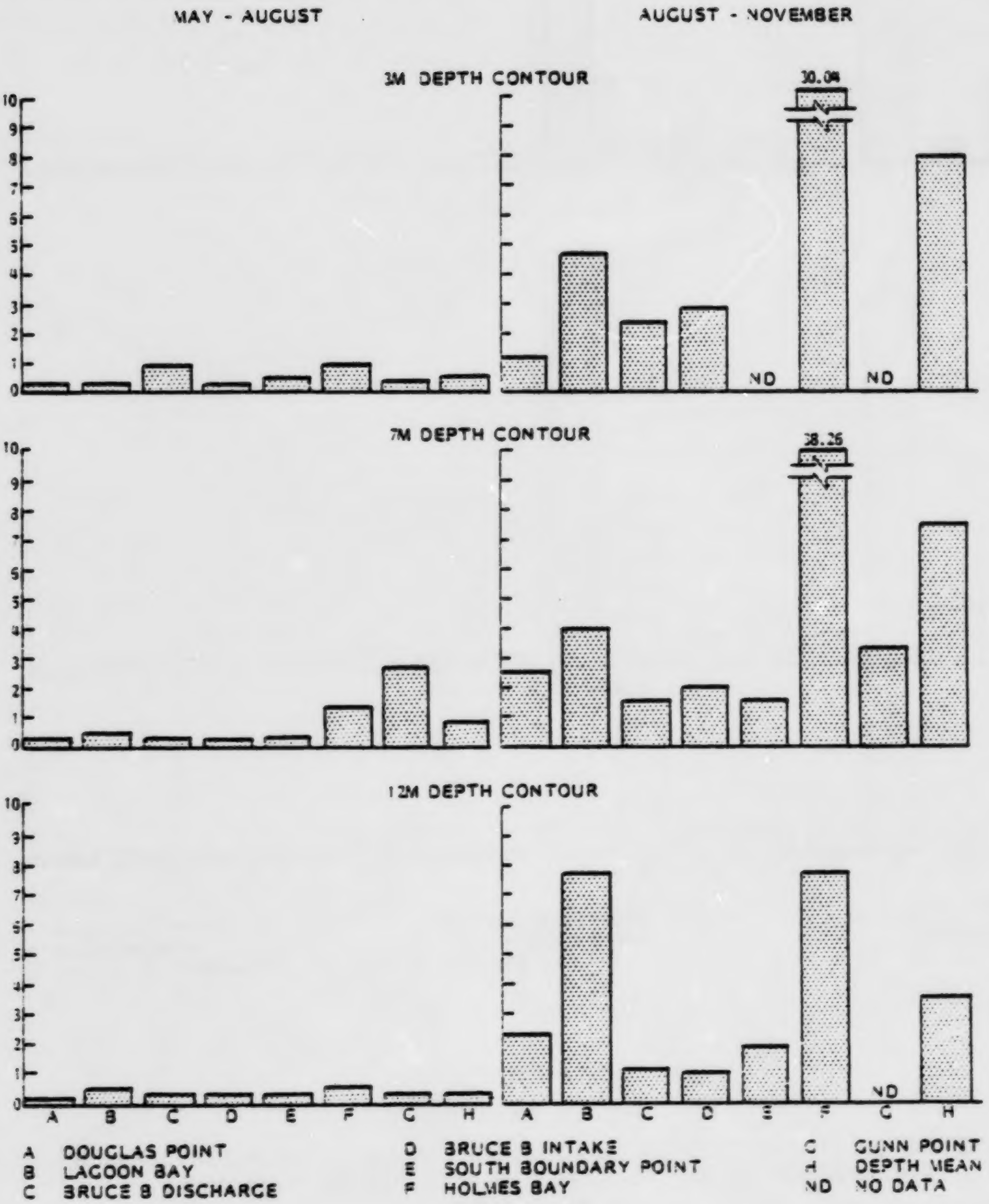


FIGURE 3.1.2-2

INORGANIC SEDIMENT (gm/cm²)
COLLECTED AT 3, 7 AND 12m SPARS
FROM MAY TO AUGUST AND AUGUST TO NOVEMBER 1979
BRUCE GS 'B'

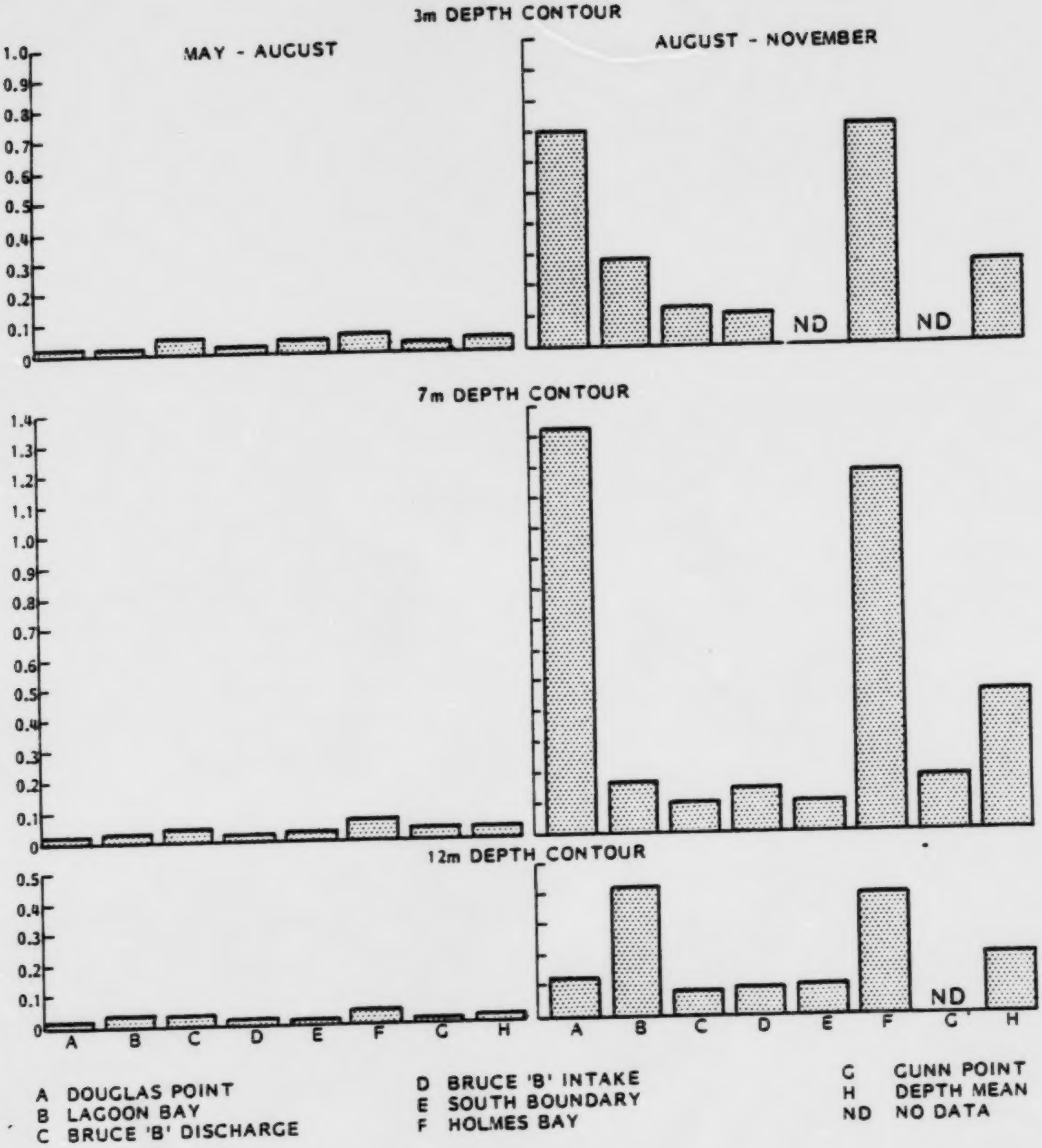


FIGURE 3.1.2-3

ORGANIC SEDIMENT (gm/cm²) COLLECTED AT 3, 7 AND 12 METRE SPARS
FROM MAY TO AUGUST AND AUGUST TO NOVEMBER 1979
BRUCE GS 'B'

There was no indication of a pattern of organic sediment accumulation along the 3 m (0.02 - 0.06 gm/cm$^2$) and 7 m (0.02 - 0.07 gm/cm$^2$) depth contours during the May-August sampling period. Along the 12 m depth contour, the organic sedimentation was usually less than at either the 3 m or 7 m depths. Lagoon Bay was the only exception when high values of 0.03 gm/cm$^2$ were recorded at both 7 and 12 m.

No distinct trends were evident in the accumulation of total organic (1.0 - 39.4 gm/cm$^2$) or inorganic (1.0 - 38.3 gm/cm$^2$) sediments along depth contours during the August-November sampling period. Organic sediment accumulation tended to be the same (0.1 gm/cm$^2$) along all depth contours. Exceptions occurred at Douglas Point 7 m (1.3 gm/cm$^2$), at all Lagoon Bay (0.2 - 0.4 gm/cm$^2$) and Holmes Bay (0.4 - 1.2 gm/cm$^2$) sampling depths and at Gunn Point 7 m (0.2 gm/cm$^2$).

Total sediment accumulation was greatest along the Gunn Point transect ($\bar{x}$ = 1.1 gm/cm$^2$) and least along the Bruce GS 'B' intake transect ($\bar{x}$ = 0.2 gm/cm$^2$) in the May-August sampling period. During the August-November sampling period the total sedimentation rate was highest along the Holmes Bay transect ($\bar{x}$ = 26.1 gm/cm$^2$) and lowest along the Bruce GS 'B' discharge and South Boundary transects ($\bar{x}$ = 1.8 gm/cm$^2$).

The May-August inorganic sediment accumulation was highest along the Gunn Point transect ($\bar{x}$ = 1.1 gm/cm$^2$) and lowest ($\bar{x}$ = 0.2 gm/cm$^2$) along the Douglas Point and Bruce GS 'B' intake transects.

The August-November inorganic sediment accumulation was greatest along the Holmes Bay transect ($\bar{x}$ = 25.3 gm/cm$^2$) and lowest ($\bar{x}$ = 1.7 gm/cm$^2$) along the Bruce GS 'B' discharge and South Boundary transects.

Organic sedimentation was highest along the Holmes Bay transect during both sampling periods when mean values of 0.06 and 0.77 gm/cm$^2$ were recorded for May-August and August-November respectively. The May-August organic sediment accumulation was least ($\bar{x}$ = 0.02 gm/cm$^2$) along the Douglas Point and Bruce GS 'B' intake transects. The minimum August-November organic sedimentation ($\bar{x}$ = 0.10 gm/cm$^2$) was recorded along the Bruce 'B' discharge and South Boundary transects.

The per cent organic content of material collected in sediment traps is presented in Table 3.1.2-1. Organic content was generally greater during the May-August sampling period (1.4-10.4%) than during the August-November period (2.4-34.2%). The Douglas Point 7 m value (34.2%) may be disproportionately high. Only one sediment tube was recovered indicative of possible stand overturning and dragging before uprighting.

## TABLE 3.1.2-1

## PER CENT ORGANIC CONTENT OF MATERIAL COLLECTED IN SEDIMENT TRAPS

## BRUCE GS 'B' - 1979

### MAY - AUGUST

| Depth (M) | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point | Depth Contour Means |
|---|---|---|---|---|---|---|---|---|
| 3 | 7.0 | 6.9 | 5.4 | 7.3 | 7.2 | 6.3 | 7.3 | 6.8 |
| 7 | 8.2 | 6.9 | 10.4 | 8.3 | 8.0 | 4.9 | 1.4 | 6.9 |
| 12 | 7.6 | 5.7 | 8.4 | 8.6 | 8.4 | 7.1 | 8.9 | 7.8 |
| Transect Means | 7.6 | 6.5 | 8.1 | 8.1 | 7.9 | 6.1 | 5.9 | |

### AUGUST - NOVEMBER

| Depth (M) | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point | Depth Contour Means |
|---|---|---|---|---|---|---|---|---|
| 3 | 5.7 | 5.8 | 4.9 | 3.5 | NA | 2.4 | NA | 4.5 |
| 7 | 34.2* | 4.2 | 6.1 | 6.5 | 5.7 | 3.1 | 5.4 | 9.4 |
| 12 | 5.5 | 5.1 | 7.0 | 8.2 | 5.4 | 5.2 | NA | 6.1 |
| Transect Means | 15.1 | 5.0 | 6.0 | 6.1 | 5.6 | 3.6 | 5.4 | |

NA - not available
* - 1 tube recovered

The per cent organic content did not vary greatly with collection depth along transects at most sampling sites. The mean difference in the per cent organic content between contours was 1.0% in May-August and 4.9% in August-November. The latter value is again probably disproportionately high due to the recovery of only one sediment tube at Douglas Point 7 m.

The per cent organic content was usually greatest along the Bruce GS 'B' intake and the Bruce GS 'B' discharge transects during both sampling periods. During May-August the mean on both transects was $\bar{x}$ = 8.1% while during August-November mean values of 6.1 and 6.0% were determined at Bruce GS 'B' intake and Bruce GS 'B' discharge respectively. The mean Douglas Point August-November per cent organic control (15.1%) is again probably disproportionately high.

### 3.1.3 Temperature, Dissolved Oxygen and Transparency

Temperature and dissolved oxygen profiles were recorded monthly between May and November at the Bruce GS 'B' intake (12 m, Spar 26) and Gunn Point (12 m, Spar 107). The recorded data are presented in Appendices F and G. The mean temperature and dissolved oxygen readings were similar among locations on each sampling date (Figure 3.1.3-1).

The maximum mean water temperature (18.6°C) was recorded on July 24 at the Bruce GS 'B' intake. The minimum mean water temperature (7.9°C) was recorded on November 21 at both sampling locations. Isothermal water temperatures were present on virtually all sampling dates (Figure 3.1.3-2). The maximum surface to bottom temperature gradient (2.8°C) occurred on August 23 at the Bruce GS 'B' intake. Thermal gradients of 2.2, 1.2 and 2.0°C were recorded at the Bruce GS 'B' intake on June 7, July 24 and September 27, respectively. The maximum water temperature gradient at Gunn Point was 2.0°C on June 7. Minimal thermal stratification occurred between the 11 and 12 m depths at both sampling sites on August 23 and between the surface and 1 m depths at the Bruce GS 'B' intake on September 27. The maximum water temperature recorded was 19.2°C on July 24 at the Bruce GS 'B' intake surface and 1 m depths. The minimum temperature recorded was 7.3°C between the 8 and 12 m depths at Gunn Point on November 21.

Hydraulic Studies Department temperature recordings at THB04 (20 m), CMB05 (14 m) and THB08 (2.5 m) between May and November are presented in Appendix H (Figure 2.1-2). These sampling sites are all north of the Biological Research Section sampling locations. The maximum surface to bottom temperature gradient (13.3°C) occurred on September 6 at THB04. Surface to bottom thermal gradients of 6.0, 4.9, 6.2 and 11.8°C were recorded at THB04 on May 22, June 19, July 9 and July 31, respectively. The maximum temperature gradient at CMB05 was 9.2°C on September 6. Thermal gradients of 4.9, 3.0, 5.6 and 5.3°C were recorded on May 22, June 18, July 9 and September 5. Temperatures

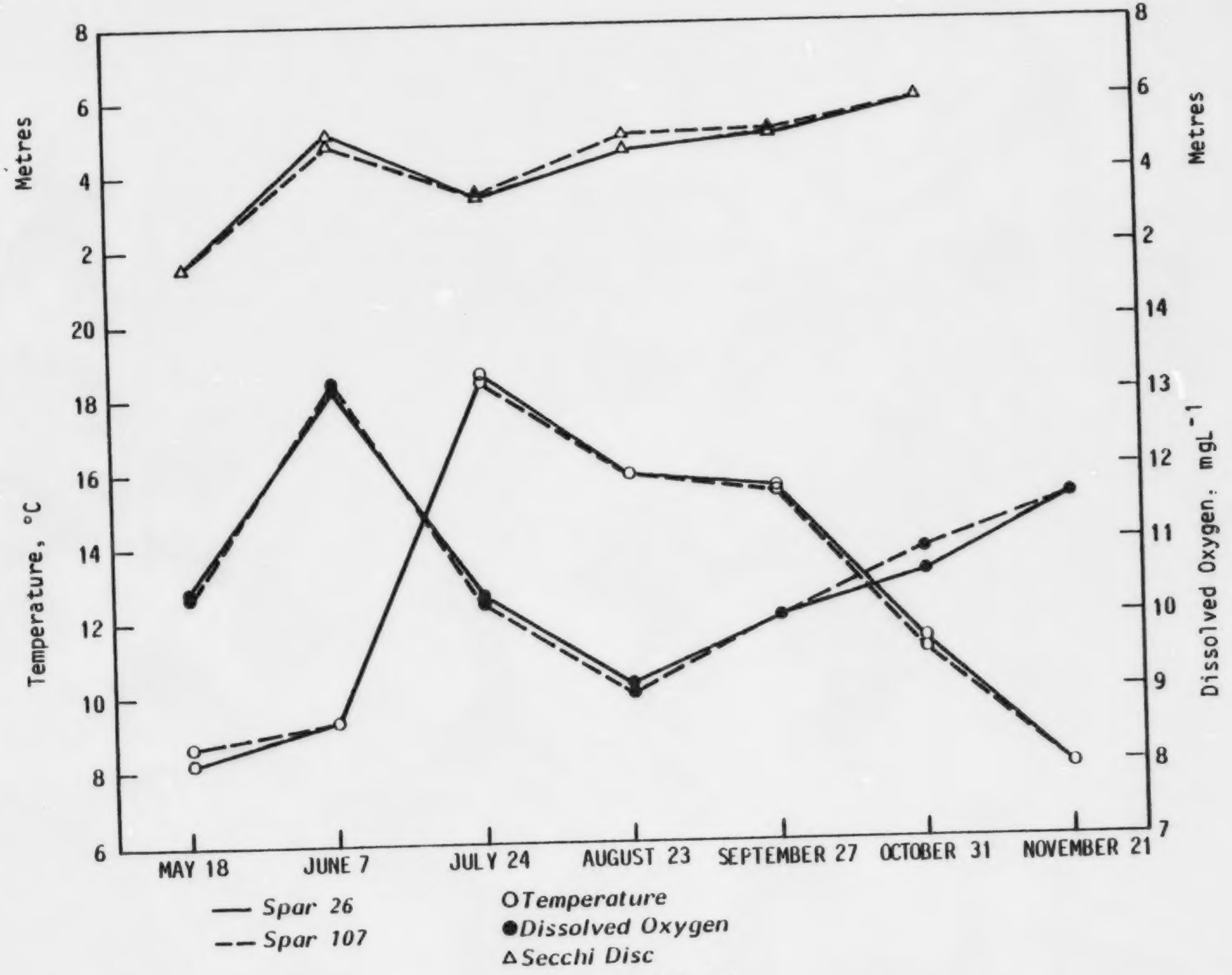


FIGURE 3.1.3-1

TEMPORAL VARIABILITY OF MEAN TEMPERATURE, MEAN DISSOLVED OXYGEN AND TRANSPARENCY BRUCE GS 'B' - 1979

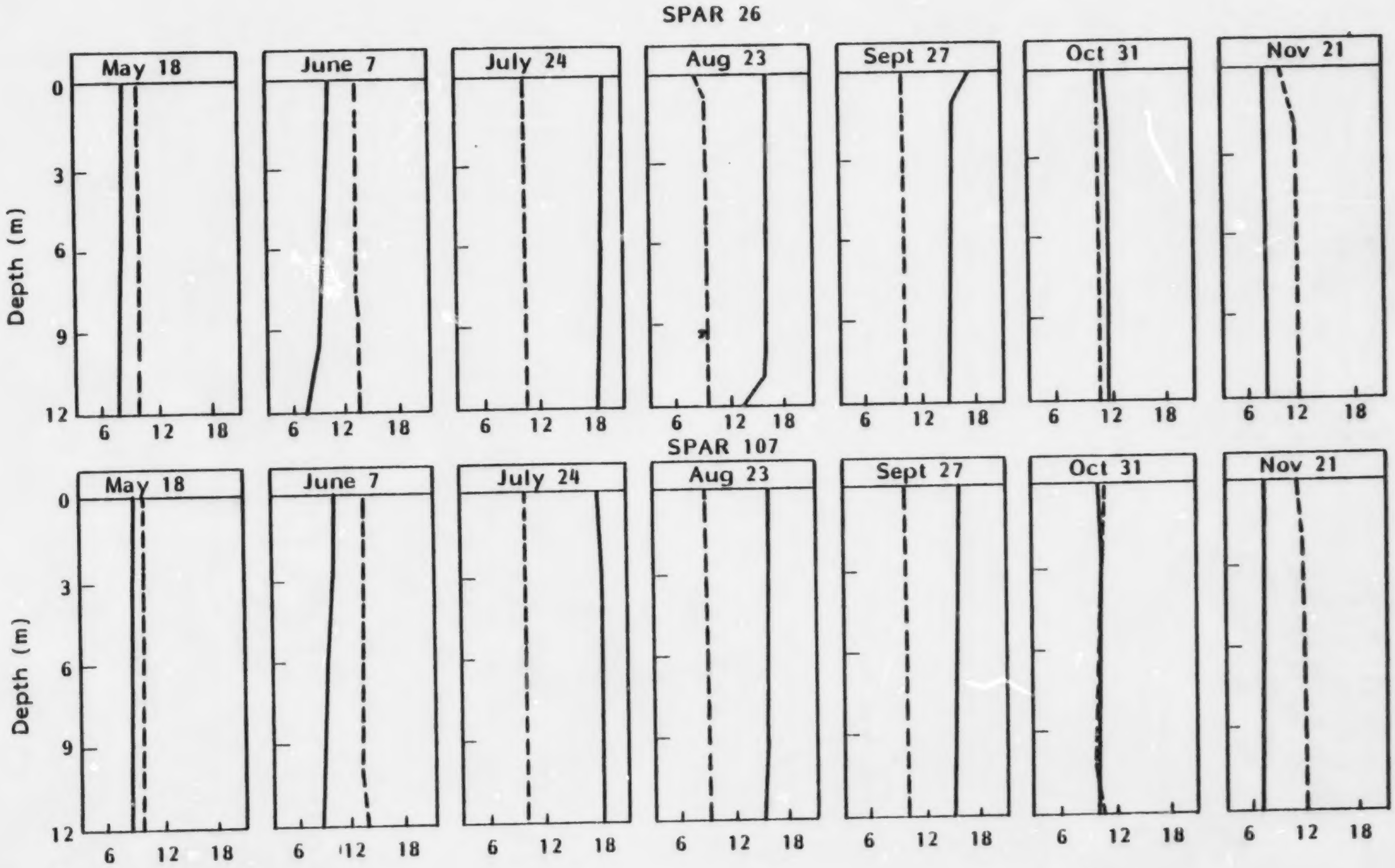


FIGURE 3.1.3-2

TEMPERATURE (°C) AND DISSOLVED OXYGEN ($mgL^{-1}$) PROFILES AT BRUCE 'B' INTAKE 12M (SPAR 26) AND GUNN POINT 12M (SPAR 107) BRUCE GS 'B' - 1979 at THB08 were isothermal on all sampling dates with a maximum 0.5°C temperature gradient on May 23. On July 31 a distinct thermocline existed between 15 m (18.3°C) and 16 m (11.8°C) at THB04. On September 6 a distinct thermocline was present between 8.0 m (18.5°C) and 9.5 m (14.2°C). Thermal stratification also occurred at CMB05. A distinct thermocline was present on September 5 between 12.0 m (18.4°C) and 13.5 m (14.1°C). On September 6 the thermocline was present between 8 m (18.5°C) and 12 m (12.0°C). The maximum temperature recorded was 20.7°C at CMB05 (3 m) on September 6. The minimum water temperature recorded was 1.6°C at THB04 (0.5 m and 5.0 m) on May 2.

The dissolved oxygen content of the water column was generally near or above saturation on all sampling dates and generally varied little through the water column (Figure 3.1.3-2). The highest mean dissolved oxygen concentrations at Gunn Point and Bruce GS 'B' occurred in June and were 13.3 and 13.1 $mgL^{-1}$ respectively.

Secchi disc readings were recorded at Spar 26 and Spar 107 coincident with the temperature and dissolved oxygen sampling (Appendices D and E). No secchi disc values were available for November. Water transparency values at both sampling locations ranged from 1.6 m on May 18 to 6.0 m on October 31. The low May values may reflect the spring runoff. The high October values coincide with the maximum turbidity values recorded at Bruce GS 'B' intake 12 m (Section 3.2.1).

## 3.2 Chemical Characteristics

### 3.2.1 Water Chemistry

Water quality analyses were performed on water samples collected at the surface and bottom of the Bruce GS 'B' intake 12 m spar (Spar 26) and at the surface of the Bruce GS 'B' discharge 3 m spar (Spar 21). Samples were collected on June 23, August 23 and October 31. The water quality data are presented in Table 3.2.1-1.

The pH of the lake water ranged from 7.7 on October 31 measured at the Bruce GS 'B' intake surface and bottom to 8.2 on August 23 at the Bruce GS 'B' intake surface. Specific conductance ranged from 17.0 mS/m (August 23) to 20.9 mS/m (October 31) both measured at Bruce GS 'B' intake bottom. The maximum (1.70 NTU) and minimum (0.35 NTU) turbidity values were recorded at the Bruce GS 'B' intake surface on October 31 and August 23, respectively. Colour was recorded as clear at all locations on all sampling occasions.

Table 3.2.1-1

## WATER CHEMISTRY BRUCE GS 'B'
## JUNE, AUGUST, OCTOBER - 1979

| Analysis | June 28 | | | August 23 | | | October 31 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Spar 21 Surface | Spar 26 Surface | Spar 26 Bottom | Spar 21 Surface | Spar 26 Surface | Spar 26 Bottom | Spar 21 Surface | Spar 26 Surface | Spar 26 Bottom |
| pH | 7.8 | 7.8 | 7.8 | 8.1 | 8.2 | 8.1 | 7.9 | 7.7 | 7.7 |
| Conductivity (mS/m) | 19.5 | 20.0 | 20.0 | 17.5 | 17.5 | 17.0 | 20.4 | 20.5 | 20.9 |
| Turbidity (NTU) | 0.85 | 0.88 | 0.75 | 0.53 | 0.35 | 0.50 | 1.30 | 1.70 | 1.01 |
| Colour | clear | clear | clear | clear | clear | clear | clear | clear | clear |
| Suspended Solids (mg/L) | | | | | | | | | |
| 105°C | 1.8 | 1.6 | 1.3 | 1.0 | 0.4* | 0.4* | 1.00 | 1.20 | 0.60 |
| 550°C | 0.6 | 0.2 | 0.8 | 0.6 | 0.4 | 0.4 | ND | ND | ND |
| Dissolved Solids (mg/L) | | | | | | | | | |
| 105°C | 116 | 113 | 115 | 118 | 114 | 124 | 120 | 118 | 120 |
| 550°C | 93 | 94 | 96 | 89 | 103 | 102 | 98 | 98 | 95 |
| Alkalinity (mg/L as Ca $CO_3$) | 78.4 | 77.6 | 79.2 | 78 | 78 | 79 | 79.0 | 76.6 | 77.0 |
| Hardness (mg/L as Ca $CO_3$) | 90.3 | 90.3 | 90.3 | 92.9 | 94.1 | 92.9 | 93 | 91 | 91 |
| Total Phosphorus (mg/L) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.005 | 0.005 | 0.005 |
| Orthophosphorous (mg/L) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.002 | <0.002 | <0.002 |
| Particulate Phosphorus (mg/L) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.005 | <0.005 | <0.005 |
| Total Nitrogen (mg/L) | 0.52 | 0.36 | 0.39 | 0.45 | 0.53 | 0.47 | 0.39 | 0.38 | 0.38 |
| Soluble Nitrogen (mg/L) | 0.20 | 0.10 | 0.11 | 0.16 | 0.17 | 0.19 | 0.10 | 0.10 | 0.10 |
| Nitrite (mg/L as $NO_2$) | <0.01 | <0.01 | <0.01 | <3 | <3 | <3 | <0.5 | <0.5 | <0.5 |
| Nitrate (mg/L as $NO_3$) | 1.2 | 1.1 | 1.1 | 1.01 | 1.22 | 0.86 | 1.16 | 1.00 | 1.00 |
| Kjeldahl Nitrogen (mg/L) | 0.25 | 0.11 | 0.14 | 0.22 | 0.25 | 0.28 | 0.13 | 0.15 | 0.15 |
| Particulate Nitrogen (mg/L) | 0.054 | 0.02 | 0.03 | 0.06 | 0.08 | 0.09 | 0.03 | 0.05 | 0.05 |
| Ammonia (μg/L) | <20 | <20 | <20 | 57 | 90 | 60 | 45 | 48 | 48 |
| Chloride (mg/L) | 13.8 | 10.5 | 11.5 | 6.3 | 5.3 | 7.2 | 7.10 | 6.60 | 6.60 |
| COD (mg/L as COD) | - | - | - | 6.0 | 6.0 | 6.0 | 10.3 | 10.3 | 12.3 |
| Sulphate (mg/L) | 15.6 | 16.0 | 14.6 | 15.4 | 14.3 | 14.5 | 16.0 | 15.6 | 15.4 |
| TOC (mg/L as C) | 1.2 | 1.9 | 1.2 | 1.2 | 1.9 | 1.2 | <1 | <1 | <1 |
| Chlorophyll a (μg/L) | 0.7 | 0.5 | 0.9 | 0.4 | <0.3 | 0.3 | 1.0 | 1.2 | 0.9 |
| Al (mg/L) | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Ca (mg/L) | 24.8 | 24.8 | 24.8 | 26 | 26 | 26 | 25.5 | 24.8 | 24.8 |
| Fe Total (mg/L) | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Dissolved (mg/L) | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| K (mg/L) | 0.92 | 0.90 | 0.90 | 1.0 | 1.2 | 1.0 | 0.8 | 0.8 | 0.8 |
| Mg (mg/L) | 6.9 | 6.9 | 6.9 | 6.8 | 7.1 | 6.8 | 7.1 | 7.1 | 7.1 |
| Na (mg/L) | 3.4 | 3.4 | 3.4 | 3.6 | 3.8 | 3.3 | 3.55 | 3.25 | 3.65 |
| Total silica (mg/L as $SiO_2$) | 1.33 | 1.37 | 1.27 | 1.16 | 1.03 | 1.32 | 1.25 | 1.27 | 1.30 |
| Dissolved silica (mg/L as $SiO_2$) | 0.52 | 0.10 | 0.53 | 0.89 | 0.94 | 0.98 | 1.07 | 1.10 | 1.10 |

* values are questionable (equal 550°C values)
ND - not determined

Spar 21 - Bruce GS 'B' discharge
Spar 26 - Bruce GS 'B' intake

Suspended solids (dry weight) were highest on June 23. Values of 1.8, 1.6 and 1.3 mg/L were recorded at the Bruce GS 'B' discharge surface and the Bruce GS 'B' intake surface and bottom, respectively. The low 105°C values (0.4 mg/L) recorded at Spar 26 surface and bottom on August 23 are questionable since these values are equivalent to the 0.4 mg/L values obtained at 550°C. No suspended solid (550°C) values were reported for October 31. All of the suspended solids values are indicative of low lake productivity within the Bruce 'B' area.

The concentration of dissolved solids was greatest on August 23 at the Bruce GS 'B' intake bottom (124 mg/L). The lowest value (113 mg/L) was recorded at the Bruce GS 'B' intake surface on June 28. The dissolved solids values at 550°C ranged from 89 to 103 mg/L at the Bruce GS 'B' discharge surface and the Bruce GS 'B' intake surface, respectively on August 23.

Alkalinity values ranged from 76.6 mg/L at the Bruce GS 'B' intake surface (October 31) to 79.2 mg/L at the Bruce GS 'B' intake bottom (June 28). Values in ths alkalinity range are indicative of moderately hard waters with buffering capabilities.

Slight variation was observed in hardness on a spatial and temporal basis. Hardness was greatest on August 23 at the Bruce GS 'B' intake surface (94.1 mg/L) and lowest on June 28 (90.3 mg/L) at all sites. The hardness values reflect the presence of extensive limestone deposits in the Bruce GS 'B' study area watershed.

Low concentrations of total phosphorous were determined at all stations throughout the sampling period. On all sampling dates values of <0.01 mg/L were measured at all locations. These total phosphorous values are less than the Bruce GS 'A' pre-operational values which ranged from 0.002 - 0.161 mg/L at Lagoon Bay (Ontario Hydro Research Division Report 80-291-K) and result in low lake productivity.

Orthophosphorous and particulate phosphorous values are similarly low with values always less than the detection limit (<0.01 mg/L).

Seasonal total nitrogen values ranged from 0.36 mg/L at the Bruce GS 'B' intake surface to 0.52 mg/L at the Bruce GS 'B' discharge surface. Both values were recorded on June 28. The Ontario Ministry of the Environment recorded total nitrogen values in May ranging from 0.37 to 0.60 mg/L near Port Elgin-Southampton in 1974-1975 (Ross and Chatterjee, 1977). A mean total nitrogen value of 0.43 mg/L was calculated over the three sampling periods.

The maximum nitrate value (mg/L as $No_3$) recorded was 1.2 mg/L at the Bruce GS 'B' discharge surface (June 28, October 31) and the Bruce GS 'B' intake surface (August 23). The lowest nitrate value (0.86 mg/L) was recorded at the Bruce GS 'B' intake bottom on August 23. The mean nitrate value for the Bruce GS 'B' site was 1.1 mg/L. The mean nitrate concentration (mg/L as $No_3$)recorded in previous preoperational studies at the Bruce GS 'A' South Boundary (1973-74) and Gunn Point (1975) was 1.0 mg/L (Ontario Hydro Research Division Report 80-281-K). Canada Centre for Inland Waters (CCIW) recorded a mean Lake Huron nitrate value (mg/L as $NO_3$) of 1.0 mg/L from 1968-1971 (Dobson et al, 1974). All nitrate values were below the limits of detection.

Ammonia concentrations in unpolluted waters usually occur in the order of 1 mg/L or less (Reid, 1961). The measured Bruce GS 'B' ammonia concentrations ranged in value from 20 µg/L at all locations on June 28 to 90 µg/L at Bruce GS 'B' intake surface on August 23. Ammonia values measured on August 23 at the Bruce GS 'B' discharge surface (57 µg/L) and the Bruce GS 'B' intake bottom (60 µg/L) were approximately 0.66 of the Bruce GS 'B' intake surface value (90 µg/L).

The maximum chloride values were recorded on June 28 when the values ranged from 10.5 mg/L (Bruce GS 'B' intake surface) to 13.8 mg/L (Bruce GS 'B' discharge surface). August 23 and October 31 chloride values declined from the June 28 maxima. On these dates the chloride values ranged from a minimum value of 5.3 mg/L to 7.2 mg/L at the Bruce GS 'B' intake surface and bottom, respectively. The August and October chloride values are very low for natural waters.

The sulphate values recorded at the sampling sites showed very little variation with location or sampling date. A low sulphate value of 14.3 mg/L was reported at the Bruce GS 'B' intake surface (August 23). The maximum sulphate values (16.0 mg/L) were recorded at the Bruce GS 'B' intake surface (June 28) and the Bruce GS 'B' discharge surface (October 31). Sulphate recorded levels offshore in the Port Elgin-Southampton area ranged from 12 to 16 mg $SO_4$/L (Ross and Chatterjee, 1977).

Aluminum and iron (total and dissolved) values were below the limits of detection (4.0 and 0.5 mg/L, respectively) on all sampling dates at all locations.

The potassium concentrations are low, but typical of those normally found in freshwater (Ontario Ministry of the Environment, 1981). Values ranged from 0.8 mg/L at all locations on October 31 to 1.2 mg/L at Bruce GS 'B' intake surface on August 23.

Minimum dissolved silica concentrations were measured on June 28 at all sites. Dissolved silica concentration on that date ranged from 0.10 mg/L at the Bruce GS 'B' intake surface to 0.53 mg/L at the Bruce GS 'B' intake bottom. Dissolved silica values increased through the August 23 and October 31 sampling periods to an October 31 maximum of 1.10 mg/L at the Bruce GS 'B' intake surface and bottom. The Bacillariophyta (diatoms) mean densities were inversely related to the seasonal dissolved silica increase. Diatom mean densities decreased from June 6 (1130 $mg/m^3$) to October 4 (38.6 $mg/m^3$).

Chlorophyll a values at Bruce GS 'B' reflect the low lake productivity. The mean chlorophyll a value was 0.7 µg/L with a range from 0.3 µg/L (August 23) to 1.2 µg/L (October 31) at Bruce GS 'B' intake surface.

### 3.2.2 Sediment Trap - Sediment Chemistry

The results of heavy metal analysis of the sediments from August and November are presented in Table 3.2.2-1. The concentrations of most of the heavy metals analyzed were usually greater during the August sampling period than in November. Exceptions include calcium, manganese, sodium and strontium which were greater during November than in August. No reason is known for these increases.

Aluminum values ranged from 25 200 mg/kg at Douglas Point (November) to 39 800 mg/kg at South Boundary (August). The mean August aluminum concentration (36 662 mg/kg) was greater than the mean November concentration (28 025 mg/kg).

Arsenic values were greater in August ($\bar{x}$ = 7.0 mg/kg) than November ($\bar{x}$ = 3.2 mg/kg). The highest arsenic concentration (8.7 mg/kg) was recorded at Bruce GS 'B' discharge in August. The minimum arsenic concentration in the sediments (2.6 mg/kg) was recorded at Gunn Point in November.

Beryllium concentrations were low over the entire Bruce GS 'B' site on both sampling dates. The beryllium concentrations ranged from 0.10 to 0.20 mg/kg at South Boundary in November and August, respectively. The measured beryllium concentrations were slightly lower in November ($\bar{x}$ = 0.12 mg/kg) than in August ($\bar{x}$ = 0.17 mg/kg).

Calcium concentrations ranged from 111 000 to 142 650 mg/kg at Douglas Point in August and November respectively. August calcium concentrations decreased southerly from Douglas Point (142 650 mg/kg) to Gunn Point (123 100 mg/kg). The calcium values are indicative of the limestone bedrock in the study area watershed.

Cadmium concentrations were lower at all sites in November ($\bar{x}$ = < 0.5 mg/kg) than in August ($\bar{x}$ = < 2.8 mg/kg). The maximum recorded cadmium concentration was 3.1 mg/kg at the Bruce GS 'B' discharge in August. Cadmium concentrations were below the limits of detection at Douglas Point (<2 mg/kg) and South Boundary (< 0.50 mg/kg) in August and November respectively. The offshore 1974 surficial sediment cadmium level at MacGregor Point was 2.97 mg/kg (Ross and Chatterjee, 1977).

Cobalt concentrations in the sediment samples were greatest for each sampling period at the Bruce GS 'B' discharge. In August and November values of 9.4 and 6.8 mg/kg were recorded at the sampling location. Minimum cobalt readings of 5.6 mg/kg were reported at Douglas Point, South Boundary and Gunn Point in November. Thomas et al (1975) reported a mean 1969 cobalt concentration of 17.1 ± 17.8 mg/kg in Lake Huron surface sediments.

## Table 3.2.2-1

### Sediment Trap Sediment Chemical Analysis
(mg/kg - dry basis)
Bruce GS 'B' - 1979

| Analysis | August | | | | November | | | |
|---|---|---|---|---|---|---|---|---|
| | Douglas Point 7 m | Bruce 'B' Dis-Charge 7 m | South Boundary 7 m | Gunn Point 7 m | Douglas Point 7 m | Bruce 'B' Dis-Charge 7 m | South Boundary 7 m | Gunn Point 7 m |
| Aluminum | 33 300 | 38 500 | 39 800 | 35 050 | 25 200 | 34 300 | 26 400 | 26 200 |
| Arsenic* | 6.3 | 8.7 | 7.4 | 5.7 | 3.0 | 3.5 | 3.6 | 2.6 |
| Barium | 270 | 288 | 357 | 256 | 260 | 300 | 260 | 280 |
| Beryllium* | 0.18 | 0.15 | 0.20 | 0.15 | 0.14 | 0.12 | 0.10 | 0.13 |
| Bromine | 32 | 29 | 34 | 32 | 26 | 27 | 23 | 18 |
| Calcium | 111 000 | 112 400 | 116 500 | 119 300 | 142 650 | 139 900 | 134 700 | 123 100 |
| Cadmium* | <2 | 3.1 | 2.5 | 3.4 | 0.5 | 0.50 | <0.50 | 0.70 |
| Cerium | 36 | 38 | 42 | 37 | 30 | 42 | 30 | 31 |
| Chlorine | 160 | 457 | 430 | 232 | 200 | 240 | 300 | 300 |
| Cobalt* | 7.9 | 9.4 | 9.1 | 8.3 | 5.6 | 6.8 | 5.6 | 5.6 |
| Chromium* | 66 | 57 | 47 | 39 | 30 | 36 | 31 | 33 |
| Cesium | 2.0 | 2.4 | 2.7 | 2.2 | 1.5 | 1.8 | 1.4 | 1.2 |
| Copper* | 26 | 32 | 25 | 29 | 14 | 16 | 12 | 12 |
| Dysprosium | 0.80 | 0.73 | 0.90 | 0.70 | 0.60 | 0.5 | 0.5 | 0.6 |
| Europium | 0.56 | 0.65 | 0.73 | 0.64 | 0.50 | 0.60 | 0.50 | 0.50 |
| Iron* | 17 000 | 24 800 | 20 050 | 21 500 | 13 800 | 18 200 | 15 300 | 15 700 |
| Hafnium | 3.4 | 4.1 | 4.3 | 3.5 | 3.7 | 5.1 | 3.4 | 4.6 |
| Mercury* | 0.36 | 0.43 | 0.27 | 0.35 | 0.13 | 0.08 | 0.08 | 0.09 |
| Iodine | 6.5 | 5.4 | 5.6 | 6.2 | 3.5 | 4.8 | 8.7 | 3.0 |
| Potassium | 12 900 | 13 200 | 13 300 | 12 100 | 9 370 | 10 450 | 9 700 | 10 400 |
| Lanthanum | 16 | 19 | 18 | 15 | 14 | 19 | 14 | 13 |
| Lutetium | 0.16 | 0.18 | 0.32 | 0.16 | 0.20 | 0.2 | 0.2 | 0.2 |
| Manganese* | 286 | 303 | 295 | 263 | 300 | 303 | 300 | 280 |
| Sodium | 4210 | 4340 | 4550 | 4100 | 4430 | 4980 | 5100 | 5800 |
| Nickel* | 20 | 35 | 19 | 21 | 11 | 15 | 10 | 14 |
| Lead* | <10 | <10 | 32 | <10 | 11 | 22 | 7 | 11 |
| Rubidium | 53 | 62 | 69 | 59 | 46 | 56 | 44 | 45 |
| Antimony | 0.60 | 1.5 | 1.3 | 3.0 | 0.20 | 0.30 | 0.20 | 0.30 |
| Scandium | 6.0 | 6.8 | 7.1 | 6.3 | 5.0 | 5.8 | 5.0 | 5.1 |
| Selenium* | 1.4 | 1.1 | 1.7 | 0.8 | 0.50 | 0.60 | 0.40 | 0.40 |
| Samarium | 3.0 | 3.1 | 2.8 | 2.9 | 2.3 | 2.8 | 2.4 | 2.4 |
| Strontium | 196 | 135 | 155 | 234 | 340 | 280 | 430 | 530 |
| Tantalum | 0.35 | 0.45 | 0.50 | 0.40 | 0.30 | 0.40 | 0.30 | 0.30 |
| Terbium | 0.36 | 0.40 | 0.42 | 0.36 | 0.30 | 0.40 | 0.30 | 0.30 |
| Thorium | 4.7 | 5.1 | 5.6 | 4.8 | 3.3 | 4.4 | 3.3 | 3.5 |
| Titanium | 1950 | 2035 | 1540 | 1710 | 1915 | 1630 | 1400 | 1000 |
| Uranium | 0.72 | 0.90 | 2.0 | 0.83 | 3.2 | 5.0 | 6.0 | 5.0 |
| Vanadium* | 50 | 54 | 55 | 48 | 27 | 42 | 20 | 34 |
| Ytterbium | 1.0 | 1.1 | 1.3 | 1.1 | 1.0 | 1.1 | 1.0 | 1.1 |
| Zinc* | 70 | 83 | 72 | 70 | 54 | 53 | 45 | 49 |

* - requested chemical analysis

Chromium values ranged from 66 (Douglas Point) to 30 mg/kg (Douglas Point) in August and November, respectively. August chromium concentrations decreased southerly from Douglas Point (66 mg/kg) to Gunn Point (39 mg/kg). This pattern was not reflected in the November data. Ross and Chatterjee (1977) reported a chromium level of 35.6 mg/kg in surficial sediments at MacGregor Point.

Copper concentrations were low. Concentrations ranged from 12 mg/kg in November at South Boundary and Gunn Point to 32 mg/kg at Bruce GS 'B' discharge in August. The mean August copper concentration was 28 mg/kg. In November, the mean concentration was 14 mg/kg. A mean Lake Huron 1969 surface sediment copper concentration of 32.1 ± 22.8 mg/kg was reported by Thomas et al (1975).

During each sampling period the iron concentration was greatest at the Bruce GS 'B' discharge. Values of 24 800 and 18 200 mg/kg were measured in August and November, respectively. Minimum iron concentrations were measured at Douglas Point in August (17 000 mg/kg) and November (13 800 mg/kg). The iron concentration measured in offshore surficial sediments at MacGregor Point in 1974 was 20 200 mg/kg (Ross and Chatterjee, 1977).

The maximum mercury concentration was 0.43 mg/kg at the Bruce GS 'B' discharge (August). A minimum mercury concentration of 0.08 mg/kg was recorded at the Bruce GS 'B' discharge and South Boundary (November). The August mean mercury value (0.35 mg/kg) was greater than the November mean value (0.10 mg/kg). No spatial pattern was evident in mercury concentration.

Manganese concentrations varied slightly on sampling dates and between sampling locations. The maximum manganese concentration was 303 mg/kg at the Bruce GS 'B' discharge in both sampling periods. A minimum value of 280 mg/kg manganese was measured at Gunn Point in November.

Nickel concentrations in the sediment samples ranged from 10 mg/kg (November) to 35 mg/kg (August). Both concentrations were measured at the Bruce GS 'B' discharge. The mean August nickel concentration (23.8 mg/kg) was greater than the mean November concentration (12.8 mg/kg). Nickel concentrations of 43.5 and 38.9 mg/kg were reported by Ross and Chatterjee (1977) and Thomas et al (1975) respectively.

The maximum lead concentration (32 mg/kg) was measured in August at South Boundary. Lead concentrations were below the limit of detection (<10 mg/kg) in August at Douglas Point, the Bruce 'B' discharge and Gunn Point. The mean lead concentration varied slightly from <16 mg/kg in August to 12 mg/kg in November. Thomas et al (1975) reported a mean 1969 Lake Huron lead concentration of 48.5 ± 33.7 mg/kg in surface sediment.

Selenium concentrations ranged from 0.4 mg/kg in November at South Boundary and Gunn Point to 1.7 mg/kg in August at South Boundary. The mean August and November selenium concentrations were 1.25 and 0.48 mg/kg respectively.

Vanadium concentrations ranged from 20 mg/kg in November (South Boundary) to 55 mg/kg in August (South Boundary). The mean August and November vanadium concentrations were 52 and 31 mg/kg respectively. A mean Lake Huron 1969 surface sediment vanadium concentration of 44.3 ± 26.7 mg/kg was reported by Thomas et al (1975).

Zinc concentrations ranged from 45 mg/kg at South Boundary (November) to 83 mg/kg at the Bruce GS 'B' discharge (August). The mean August and November zinc concentrations were 74 and 50 mg/kg, respectively. Thomas et al (1975) reported a mean 1969 zinc concentration of 61.7 ± 47.9 mg/kg in Lake Huron surface sediments.

### 3.2.3 Sediment Sample Chemistry

Sediment samples were collected in August at the proposed intake location and at Bruce GS 'B' discharge 3 m. These samples were not analyzed for heavy metals due to the large substrate size ( 16 mm). Selected samples of smaller sized substrate were collected in September. Again, sample particle size prohibited heavy metal analysis. Boulder and cobble are the predominant substrate components at these locations. Sand and silt, the preferred particle sizes, were not found by the divers along these transects within the sampling areas (Figure 3.1.1-1).

## 3.3 Biological Characteristics

### 3.3.1 Phytoplankton

#### Species Composition

The species composition and mean densities (mg/m$^3$) of the phytoplankton collected on June 6, August 23 and October 4 are presented in Table 3.3.1-1. Complete data are presented in Appendix I.

Phytoplankton density was highest on June 6 when the mean total biomass was 1145 mg/m$^3$. Their density was substantially lower on August 23 and October 4. Mean total biomass on these days were 123 and 158 mg/m respectively. High phytoplankton biomass during the spring-early summer is typical and represents the spring diatom increase.

As a group the Bacillariophyta (diatoms) dominated the phytoplankton on June 6 and August 23 while the cyanophyte (blue-green alga) made up the largest portion of the phytoplankton biomass on October 4.

The most prominent taxa present on June 6 were the diatoms *Rhizosolenia* and *Tabellaria fenestrata* which represented 39 and 32% of the total biomass respectively. *Melosira granulata* was also prominent on this day contributing to 20% of the total biomass. Unidentified pennales made up the largest part (31%) of the phytoplankton biomass on August 23. The diatoms *M. granulata* and *T. fenestrata* were the second and third most prominant taxa present on this day, representing 16 and 14% of the biomass, respectively. On October 4, the cyanophyte (blue-green alga) *Chroococcus* was the main taxon present contributing to 29% of the total biomass. The chrysophyte (yellow-green alga), *Dinobryon sociale*, the pyrrophyte (flagellate) *Peridinium* and the diatoms *T. fenestrata* and *F. crotonensis* were also prominent representing 12, 12, 11 and 8% of the total biomass, respectively. *T. fenestrata* which was prominent on all three sampling dates, along with *F. crotonensis* were found to be the two main phytoplankton taxa in the nearshore area of northwestern Lake Huron between August 1973 and July 1975 (Brown, 1978).

#### Distribution of Phytoplankton Assemblages

Three phytoplankton assemblages were identified by Mutual Information Analysis performed on June 6 data (Table 3.3.1-2). Assemblage 1 dominated by *Rhizosolenia* was the predominant assemblage and was found at 22 of the 28 sampling locations (Figure 3.3.1-1).

## Table 3.3.1-1

## SPECIES COMPOSITION AND MEAN DENSITY (mg/m$^3$) OF PHYTOPLANKTON ON JUNE 6, AUGUST 23, AND OCTOBER 4, 1979 AT BRUCE GS 'B'

| Taxa | June 6 | | August 23 | | October 4 | |
|---|---|---|---|---|---|---|
| | % | Mean Density mg/m$^3$ | % | Mean Density mg/m$^3$ | % | Mean Density mg/m$^3$ |
| **Cyanophyta** | | | | | | |
| *Anabaena* sp | | | 1.6 | 2.0 | 4.8 | 7.8 |
| *Aphanizamenon flos-aquae* | <0.1 | 0.3 | <0.1 | <0.1 | | |
| *Chroococcus* sp | | | 0.7 | 0.9 | 29.1 | 47.4 |
| *Merismopedia* sp | | | <0.1 | <0.1 | | |
| *Microcystis* sp | <0.1 | <0.1 | 0.1 | 0.2 | | |
| *Oscillatoria* | <0.1 | 0.3 | 0.2 | 0.3 | 0.1 | 0.2 |
| **Chlorophyta** | | | | | | |
| *Ankistrodesmus falcatus* | <0.1 | <0.1 | <0.1 | <0.1 | | |
| *Ankistrodesmus falcatus* V. mirabilis | <0.1 | 0.1 | <0.1 | <0.1 | | |
| *Cosmarium* sp | | | 3.8 | 4.7 | 0.3 | 0.5 |
| *Crucigenia* sp | | | <0.1 | 0.1 | <0.1 | <0.1 |
| *Elakatothrix gelatinosa* | | | 0.3 | 0.3 | <0.1 | 0.1 |
| *Franceia* sp | | | | | 0.1 | 0.2 |
| *Gloeocystis* sp | | | | | 0.4 | 0.7 |
| *Oocystis* sp | | | 5.6 | 6.9 | 2.2 | 3.6 |
| *Palmella* sp | | | <0.1 | <0.1 | | |
| *Pediastrum* sp | <0.1 | 1.0 | 0.3 | 0.3 | | |
| *Scenedesmus bijuga* | | | | | <0.1 | <0.1 |
| **Bacillariophyta** | | | | | | |
| *Asterianella formosa* | 0.2 | 1.6 | | | | |
| *Asterionella gracillima* | 1.0 | 10.9 | 2.5 | 3.1 | 3.5 | 5.6 |
| *Cocconeis* sp | | | | | 0.1 | 0.2 |
| *Cymbella* sp | <0.1 | 0.4 | 1.0 | 1.2 | <0.1 | 0.1 |
| *Diatoma* sp | 2.0 | 23.0 | 5.7 | 7.0 | | |
| *Fragilaria* sp | 0.6 | 6.6 | 1.4 | 1.7 | 0.1 | 0.2 |
| *Fragilaria crotonensis* | 1.9 | 21.9 | 7.8 | 9.6 | 8.3 | 13.5 |
| *Melosira granulata* | 19.6 | 224.0 | 16.0 | 19.7 | | |
| *Rhizosolenia* sp | 39.3 | 449.8 | 0.7 | 0.9 | | |
| *Synedra* sp | 0.1 | 0.8 | | | | |
| *Tabellaria fenestrata* | 32.4 | 371.4 | 14.4 | 17.7 | 11.0 | 18.0 |
| Unidentified Pennales | 1.7 | 19.6 | 30.6 | 37.6 | 0.6 | 1.0 |
| **Chrysophyta** | | | | | | |
| *Dinobryon sociale* | 0.7 | 7.8 | 1.9 | 2.3 | 12.4 | 20.1 |
| **Cryptophyta** | | | | | | |
| *Cryptomonas* sp | 0.1 | 0.5 | 0.6 | 0.7 | 7.0 | 6.2 |
| *Rhodomonas minuta* | 0.4 | 4.9 | 0.8 | 0.9 | 4.5 | 7.4 |
| **Pyrrophyta** | | | | | | |
| *Ceratium hirudinella* | | | | | 3.1 | 5.0 |
| *Peridinium* sp | | | 3.8 | 4.7 | 12.3 | 20.0 |
| Mean Total Biomass | | 1144.9 | | 122.8 | | 157.8 |

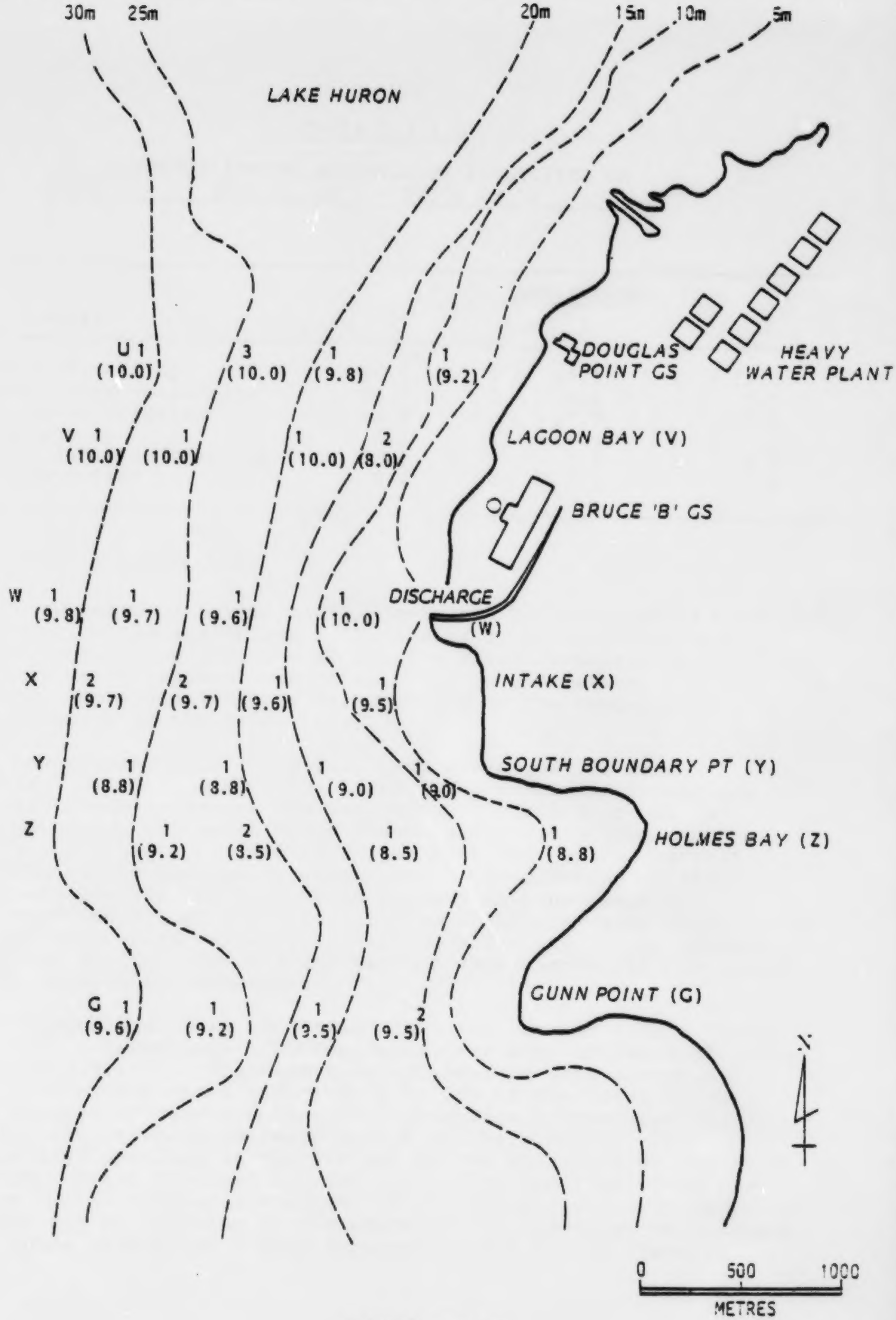

30m
25m
20m
15m
10m
5m
LAKE HURON
U 1 (10.0)
3 (10.0)
1 (9.8)
1 (9.2)
DOUGLAS POINT GS
HEAVY WATER PLANT
V 1 (10.0)
1 (10.0)
1 (10.0)
2 (8.0)
LAGOON BAY (V)
BRUCE 'B' GS
W 1 (9.8)
1 (9.7)
1 (9.6)
1 (10.0)
DISCHARGE
(W)
X 2 (9.7)
2 (9.7)
1 (9.6)
1 (9.5)
INTAKE (X)
Y 1 (8.8)
1 (8.8)
1 (9.0)
1 (9.0)
SOUTH BOUNDARY PT (Y)
Z 1 (9.2)
2 (8.5)
1 (8.5)
1 (8.8)
HOLMES BAY (Z)
GUNN POINT (G)
G 1 (9.6)
1 (9.2)
1 (8.5)
2 (9.5)
N
0
500
1000
METRES

FIGURE 3.3.1-1

DISTRIBUTION OF PHYTOPLANKTON
ASSEMBLAGES AND SURFACE WATER TEMPERATURES (°C)
ON JUNE 6, 1979 - BRUCE GS 'B'

151213 RD

## Table 3.3.1-2

## PHYTOPLANKTON ASSEMBLAGES IDENTIFIED ON JUNE 6, 1979 - BRUCE GS 'B'

| Species | Assemblage 1 | Assemblage 2 | Assemblage 3 |
|---|---|---|---|
| *Rhizosolenia* sp | 46.5* | 27.1 | 21.9 |
| *Tabellaria fenestrata* | 31.8 | 45.4 | 5.7 |
| *Melosira granulata* | 14.5 | 17.7 | 69.9 |
| *Diatoma* sp | 0.1 | 4.0 | .0 |
| *Fragilaria crotonensis* | 2.2 | 1.9 | 0.4 |
| Unidentified 1 | 0.8 | 2.3 | .0 |

* Mean % composition

The occurrence of assemblage 2, dominated by *T. fenestrata* was sporadic, while assemblage 3, dominated by *M. granulata* was only found 1.5 km offshore at Douglas Point (transect U). Surface water temperatures on this day ranged between 8.0 and 10.0°C. No spatial trends were obvious in the temperature distribution of the study area.

Two assemblages were identified from the August 23 data (Table 3.3.1-3). Assemblage 1 was the predominant assemblage on all transects except the Lagoon Bay (V) and Bruce GS 'B' discharge (W) transects where assemblage 2 was predominant (Figure 3.3.1-2). Unidentified pennales made up the largest portion of the biomass in assemblage 1 contributing to 38%. *M. granulata* was the main taxon present in assemblage 2, representing 34% of the total biomass. Surface water temperatures in the study area varied little on this day and ranged between 16.1 and 16.7°C. The distribution of assemblages did not appear to be related to temperature.

Five assemblages were identified from the October 4 data (Table 3.3.1-4). Assemblage 1 predominated over most of the study area (Figure 3.3.1-3). The main taxon present in this assemblage was *Chroococcus* which contributed to 39% of the total biomass. The biomass of taxa contained in assemblage 2 consisted mainly of *Peridinium* which represented 82% of the biomass. This assemblage occurred at the 1.0 and 1.5 km locations on the South Boundary Point transect (Y) and the 1.0 km location along the Bruce GS 'B' discharge transect (W). Assemblage 3 only occurred at the 2.0 km location at the Bruce GS 'B' discharge on transect (W) while assemblage 4 only occurred at the 2.0 km location

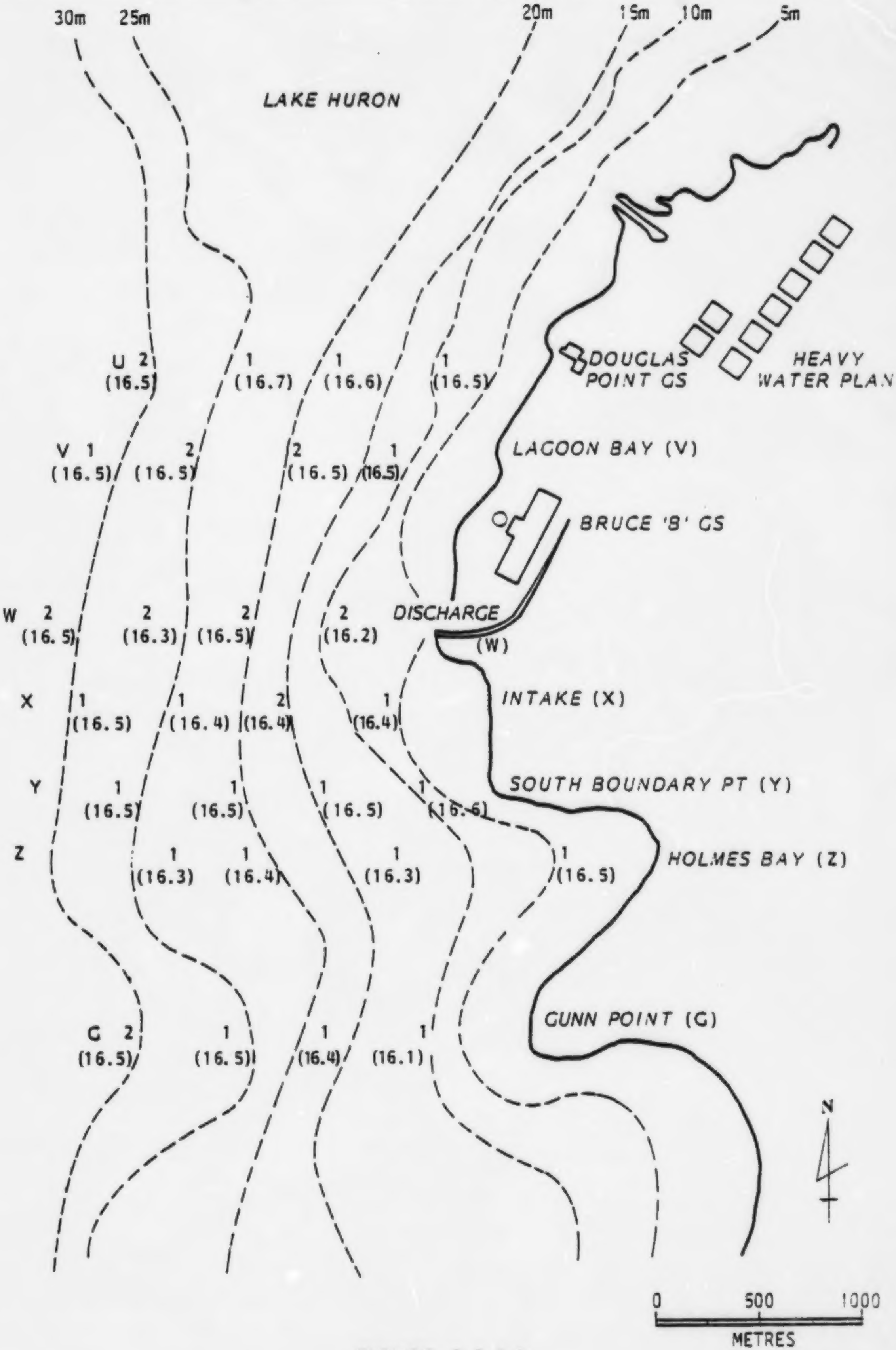

30m
25m
20m
15m
10m
5m
LAKE HURON
U 2 (16.5)
1 (16.7)
1 (16.6)
1 (16.5)
DOUGLAS POINT GS
HEAVY WATER PLAN
V 1 (16.5)
2 (16.5)
2 (16.5)
1 (16.5)
LAGOON BAY (V)
BRUCE 'B' GS
W 2 (16.5)
2 (16.3)
2 (16.5)
2 (16.2)
DISCHARGE
(W)
X 1 (16.5)
1 (16.4)
2 (16.4)
1 (16.4)
INTAKE (X)
Y 1 (16.5)
1 (16.5)
1 (16.5)
1 (16.6)
SOUTH BOUNDARY PT (Y)
Z
1 (16.3)
1 (16.4)
1 (16.3)
1 (16.5)
HOLMES BAY (Z)
G 2 (16.5)
1 (16.5)
1 (16.4)
1 (16.1)
GUNN POINT (G)
N
0
500
1000
METRES

FIGURE 3.3.1-2

DISTRIBUTION OF PHYTOPLANKTON ASSEMBLAGES AND SURFACE WATER TEMPERATURES (°C) ON AUGUST 23, 1979 - BRUCE GS 'B'

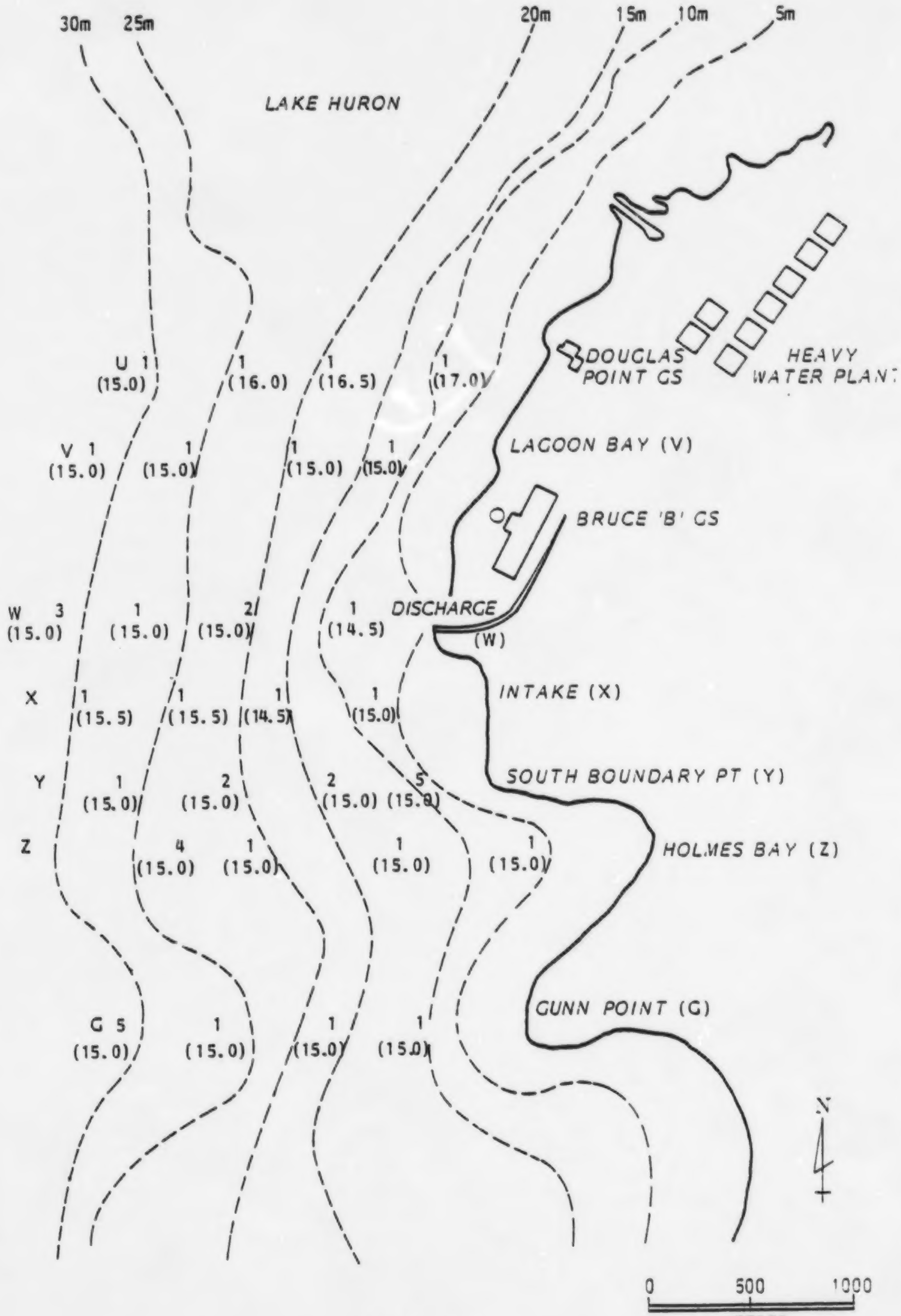

30m
25m
20m
15m
10m
5m
LAKE HURON
U 1 (15.0)
1 (16.0)
1 (16.5)
1 (17.0)
DOUGLAS POINT GS
HEAVY WATER PLANT
V 1 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
LAGOON BAY (V)
BRUCE 'B' GS
W 3 (15.0)
1 (15.0)
2 (15.0)
1 (14.5)
DISCHARGE
(W)
X 1 (15.5)
1 (15.5)
1 (14.5)
1 (15.0)
INTAKE (X)
Y 1 (15.0)
2 (15.0)
2 (15.0)
5 (15.0)
SOUTH BOUNDARY PT (Y)
Z 4 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
HOLMES BAY (Z)
GUNN POINT (G)
G 5 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
N
0
500
1000
METRES

FIGURE 3.3.1-3

DISTRIBUTION OF PHYTOPLANKTON ASSEMBLAGES AND SURFACE WATER TEMPERATURES (°C) ON OCTOBER 4, 1979 - BRUCE GS 'B'

151217 RD

## Table 3.3.1-3

## PHYTOPLANKTON ASSEMBLAGES IDENTIFIED ON AUGUST 23, 1979 - BRUCE GS 'B'

| Taxa | Assemblage 1 | Assemblage 2 |
|---|---|---|
| Unidentified pennales | 37.9* | 22.6 |
| *Melosira granulata* | 0.0 | 34.0 |
| *Tabellaria fenestrata* | 11.8 | 12.4 |
| *Fragilaria crotonensis* | 10.6 | 4.5 |
| *Diatoma* sp | 7.9 | 4.7 |
| *Oocystis* sp | 6.7 | 6.3 |
| *Peridinium* sp | 3.8 | 4.5 |
| *Cosmarium* sp | 7.2 | 0.0 |
| *Asteriohella gracillima* | 3.6 | 2.0 |
| *Dinobryon sociale* | 2.2 | 1.8 |
| *Anabaena* sp | 1.7 | 2.3 |
| *Fragilaria* sp | 1.0 | 0.8 |

* Mean % Composition

on the Gunn Point transect (G). The main taxon present in this assemblage was *Ceratium hirudinella.* On this day surface water temperature ranged between 14.5 and 17.0°C with temperatures of 16.0°C and higher only found at the northern limit of the study area along the Douglas Point transect (U). This transect is closest to the Bruce GS 'A' discharge.

### Density Distributions of Main Phytoplankton Taxa

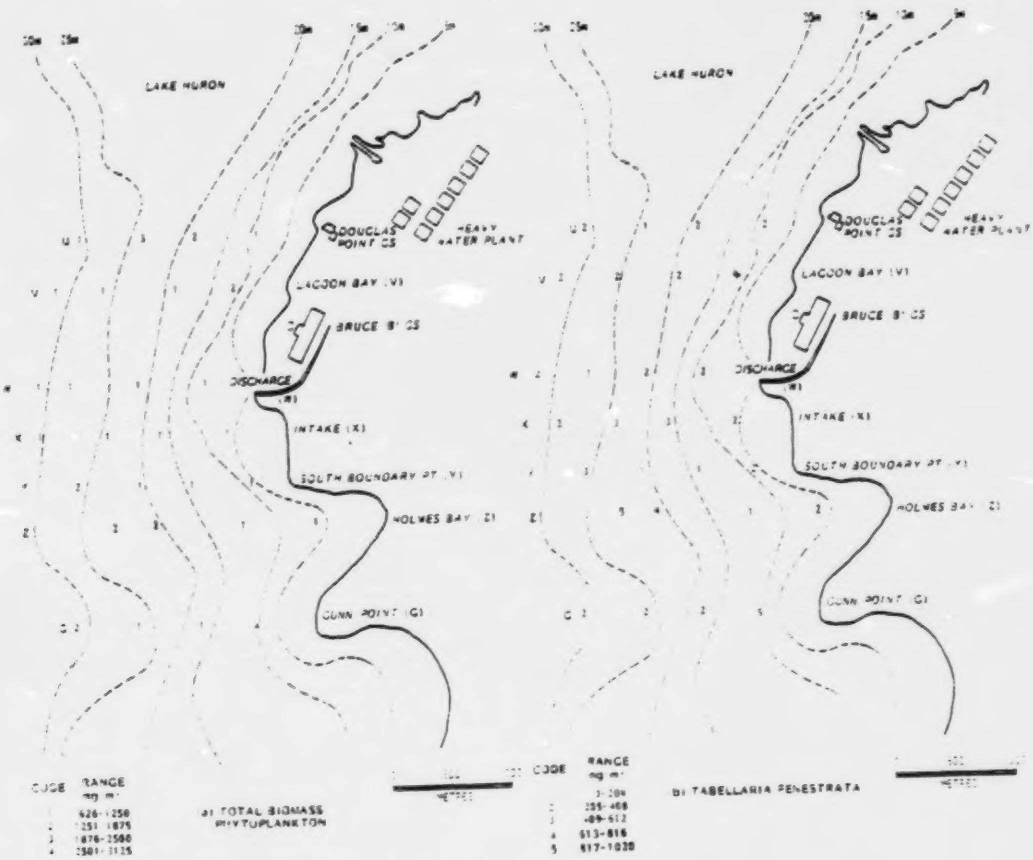
Total phytoplankton biomass ranged between 647 and 3122 gm/m$^3$. Highest density was found at the 0.5 km offshore location at Gunn Point (G) (Figure 3.3.1-4a). Densities at most locations were below 1250 gm/m$^3$. The density of *T. fenestrata* ranged from 123 to 1018 gm/m$^3$. Highest density of this taxon was found 0.5 km offshore at Gunn Point (G). No trend was obvious in the density distribution of *T. fenestrata* on this day (Figure 3.3.1-4b). *Rhizosolenia* densities ranged from 210 - 785 mg/m$^3$ with no trends obvious in its distribution (Figure 3.3.1-4c).

On August 23 total phytoplankton biomass ranged between 45 and 363 mg/m$^3$. Generally higher densities were found along the Bruce GS 'B' intake transect (X) (Figure 3.3.1-5a). The low phytoplankton density encountered on this day was probably a result of an upwelling that occurred in mid-August that resulted in low temperatures for the remainder of the month (Ontario Hydro Research Division Report in preparation - Bruce GS 'A' 1979 Postoperational Survey). The densities of the unidentified pennales varied between 12 and 83 mg/m$^3$ and were lower along the Douglas Point (U) and Lagoon Bay (V) transects than along the

## Table 3.3.1-4

## PHYTOPLANKTON ASSEMBLAGES IDENTIFIED ON BRUCE GS 'B' - October 4, 1979

| Taxa | Assemblages | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| *Chroococcus* sp | 39.3 | 4.5 | 15.9 | 7.3 | 19.9 |
| *Dinobryon sociale* | 17.2 | 2.8 | 9.6 | 5.7 | 10.4 |
| *Peridinium* sp | 0.6 | 82.1 | 0.0 | 0.0 | 0.0 |
| *Tabellaria fenestrata* | 9.0 | 0.0 | 45.8 | 13.5 | 2.4 |
| *Fragilaria crotonensis* | 10.4 | 4.1 | 5.5 | 4.7 | 3.4 |
| *Cryptomonas* sp | 8.5 | 2.6 | 11.6 | 1.4 | 4.2 |
| *Anabaena* sp | 0.6 | 0.0 | 0.0 | 61.0 | 1.7 |
| *Rhodomonas minuta* | 6.1 | 1.3 | 3.8 | 2.5 | 3.1 |
| *Asterionella gracillima* | 4.2 | 2.4 | 1.6 | 3.9 | 2.7 |
| *Ceratium hirudinella* | 0.0 | 0.0 | 0.0 | 0.0 | 38.4 |
| *Oocystis* sp | 3.5 | 0.3 | 0.1 | 0.0 | 3.0 |


LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE (W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
METRES
CODE RANGE mg/m³
1 626-1250
2 1251-1875
3 1876-2500
4 2501-3125
(a) TOTAL BIOMASS PHYTOPLANKTON
CODE RANGE mg/m³
1 0-204
2 205-408
3 409-612
4 613-816
5 817-1020
(b) TABELLARIA FENESTRATA

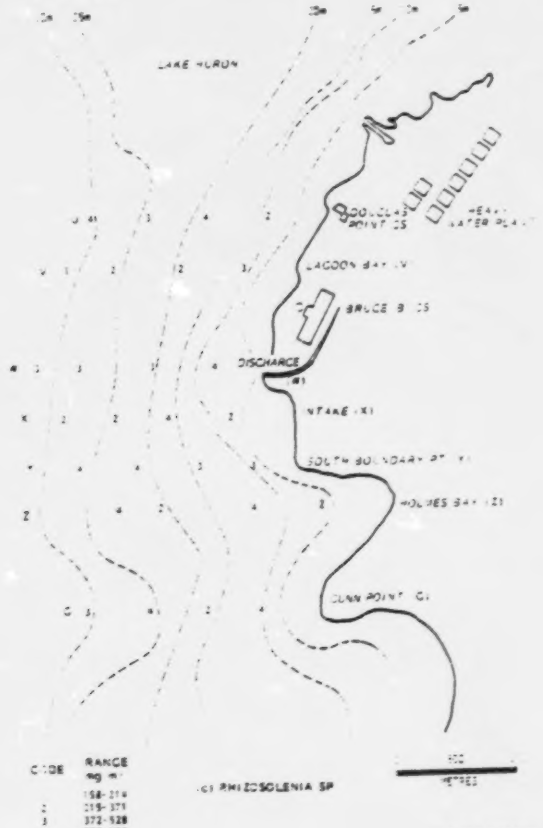

LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE (W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
METRES
CODE RANGE mg/m³
1 158-214
2 215-371
3 372-528
4 529-785
(c) RHIZOSOLENIA SP

FIGURE 2.3.1-4
DENSITY (mg/m³) DISTRIBUTION OF (a) TOTAL PHYTOPLANKTON BIOMASS
(b) TABELLARIA FENESTRATA AND (c) RHIZOSOLENIA SP
ON JUNE 6, 1979 - BRUCE GS 'B'

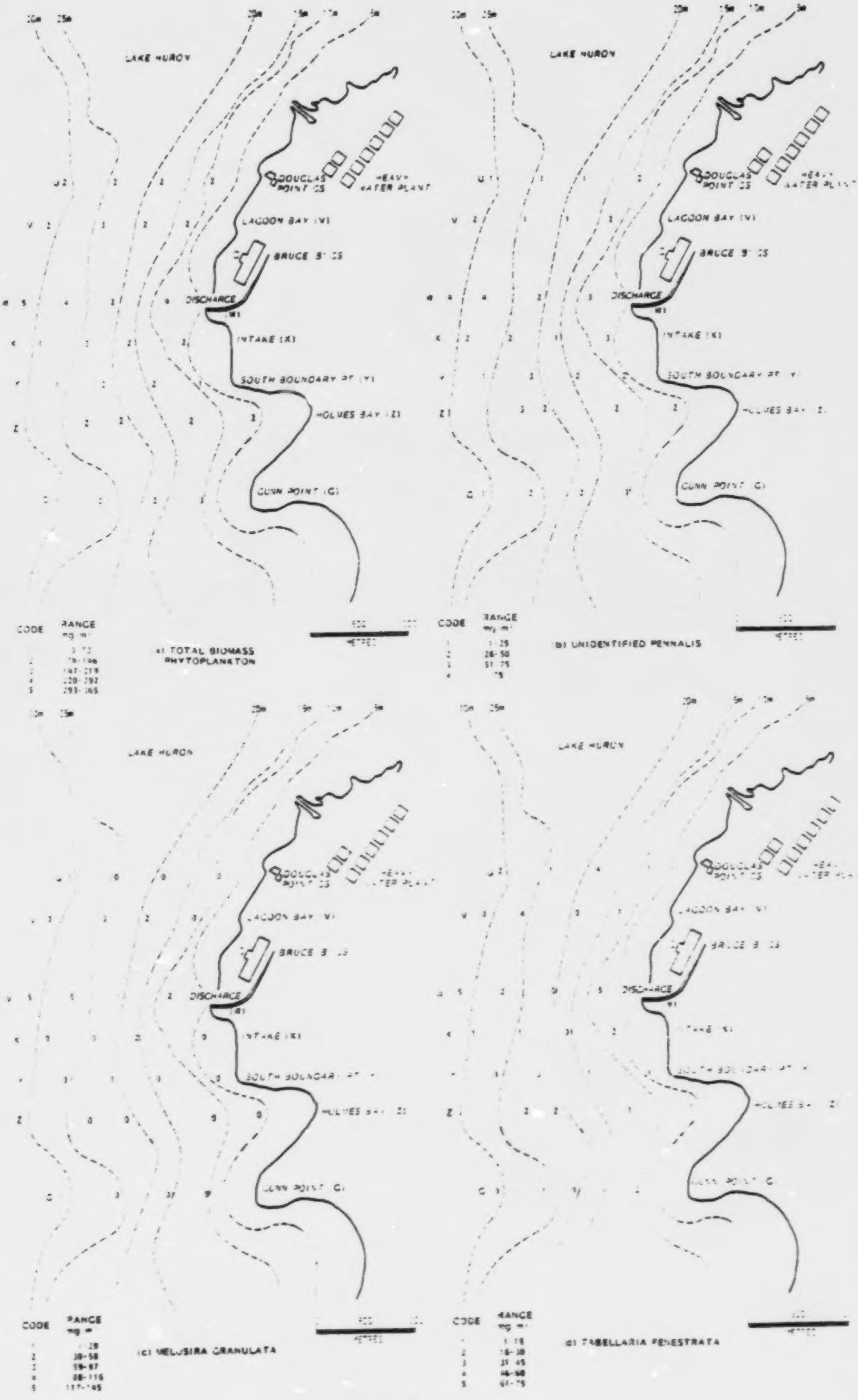

LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
20m
15m
10m
5m
30m
25m
METRES
CODE
RANGE mg/m³
1 1-73
2 74-146
3 147-219
4 220-292
5 293-365
(a) TOTAL BIOMASS PHYTOPLANKTON
1 1-25
2 26-50
3 51-75
4 75
(b) UNIDENTIFIED PENNALIS
1 1-29
2 30-58
3 59-87
4 88-116
5 117-145
(c) MELOSIRA GRANULATA
1 1-15
2 16-30
3 31-45
4 46-60
5 61-75
(d) TABELLARIA FENESTRATA

FIGURE 2.3.1-5
DENSITY (mg/m³) DISTRIBUTION OF (a) TOTAL PHYTOPLANKTON BIOMASS (b) UNIDENTIFIED PENNALES (c) MELOSIRA GRANULATA AND (d) TABELLARIA FENESTRATA ON AUGUST 23, 1979 - BRUCE GS 'B' 151220 RD

remaining transects (Figure 3.3.1-5b). Highest densities were found at the 1.5 and 2.0 km offshore locations on the Bruce GS 'B' discharge transect (W). The occurrence of *M. granulata* in the study area was sporadic (Figure 3.3.1-5c). Highest densities were found at the 1.5 and 2.0 km offshore locations on the Bruce GS 'B' transect (W). The density of *T. fenestrata* ranged between 0 and 75 mg/m$^3$. Highest densities were again found along the Bruce GS 'B' discharge transect (0.5 and 2.0 km location, Figure 3.3.1-5d). Higher densities along the Bruce GS 'B' discharge transect were not related to the temperature distribution (see Figure 3.3.1-2).

On October 4, total phytoplankton biomass ranged between 70 and 643 gm/m$^3$. At most spars total biomass was less than 250 mg/m$^3$ (Figure 3.3.1-6a). Highest density of 643 mg/m$^3$ was found at the 1.0 km location at the Bruce GS 'B' discharge (W). *Chroococcus* density ranged from 7 to 99 mg/m$^3$ (Figure 3.3.1-6b). No trend was obvious in the density distribution of this species.

### 3.3.2 Zooplankton

#### Species Composition

The species composition and mean densities (No/m$^3$) of the rotifers and crustacean zooplankton on June 6, August 23 and October 4 are presented in Tables 3.3.2-1 and 3.3.2-2, respectively. Complete data are presented in Appendix J.

The rotifers occurred in highest abundance on June 6 (9732/m$^3$) followed by October 4 (9025/m$^3$) and were least abundant on August 23 (6136/m$^3$). The most abundant rotifer taxon present on June 6 was *Synchaeta* which represented 68% of the total number of rotifers collected (*Synchaeta* tends to contract upon preservation such that speciation is frequently not possible). The two *Synchaeta* species identified, *S. oblonga* and *S. pectinata* contributed to 11 and 8% of the total numbers respectively. *Notholca squamula* was the second most abundant taxon present with a relative abundance of 13%. *Synchaeta* and *Notholca* have frequently been described as winter and spring taxa (Hutchinson, 1967). The most abundant rotifer taxon present on August 28 was *Conochilus unicornis* whose relative abundance on this day was 59%. *Asplanchna, Polyarthra dolichoptera* and *Kellicottia longispina* were also prominant on this day contributing to 9, 9 and 8% of the rotifer numbers. The main rotifers present on this day have generally been found to be perennial members of the limnoplankton of lakes in the temperate zone with spring and early summer maxima (Hutchinson, 1967). On October 4, *Trichotria tetractis* was the most abundant species present followed by *Polyarthra dolichoptera*. Their relative abundances were 30 and 26%, respectively. *Polyarthra vulgaris* was also prominant on this day contributing to 15% of the total number of rotifers. The principal rotifers identified on the three sampling dates are common in the temperate region and all except *Trichotria tetractis* have been recorded for the Great Lakes (Nauwerck, 1978). Rotifers recorded

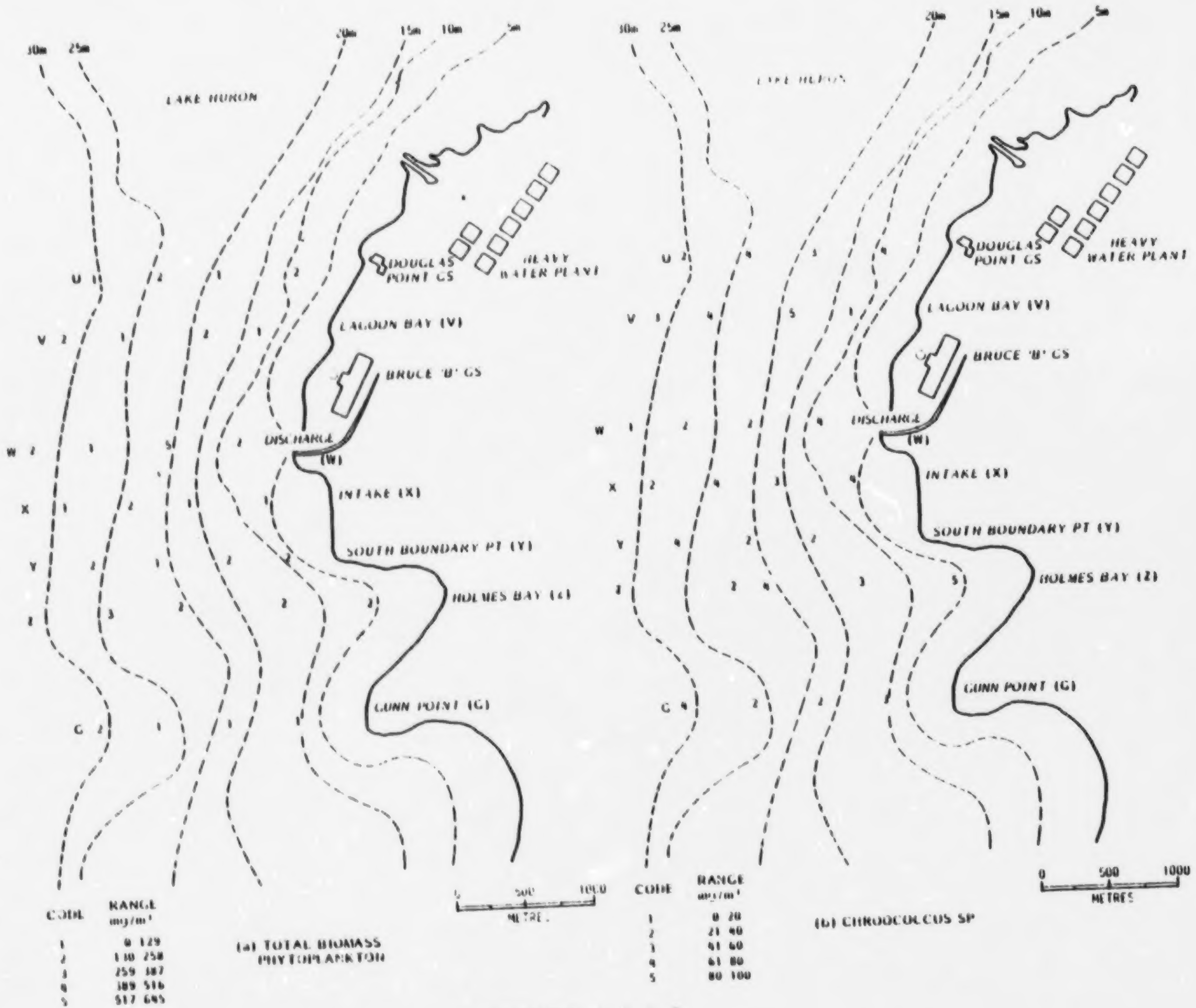

30m
25m
20m
15m
10m
5m
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE (W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
U
V
W
X
Y
Z
G
0 500 1000
METRES
CODE RANGE mg/m³
1 0 129
2 130 258
3 259 387
4 389 516
5 517 645
(a) TOTAL BIOMASS PHYTOPLANKTON
CODE RANGE mg/m³
1 0 20
2 21 40
3 41 60
4 61 80
5 80 100
(b) CHROOCOCCUS SP

FIGURE 3.3.1 6

DENSITY (mg/m³) DISTRIBUTION OF (a) TOTAL PHYTOPLANKTON BIOMASS AND (b) CHROOCOCCUS ON OCTOBER 4, 1979 - BRUCE GS 'B'

## Table 3.3.2-1

## SPECIES COMPOSITION OF ROTIFERS COLLECTED ON JUNE 6, AUGUST 23, AND OCTOBER 4, 1979 AT BRUCE GS 'B', LAKE HURON

| Taxa | Per Cent Composition | | | | | |
|---|---|---|---|---|---|---|
| | June 6 | | August 23 | | October 4 | |
| | % | Mean Density No/$m^3$ | % | Mean Density No/$m^3$ | % | Mean Density No/$m^3$ |
| *Trichotria tetractis* | 0.2 | 17.9 | 0.2 | 11.0 | 7 | 2 |
| *Keratella cochlearis* | 5.8 | 562.5 | 5.7 | 346.4 | 30.0 | 2703.6 |
| *Keratella quadrata* | 0.4 | 35.7 | 0.1 | 7.1 | 0.1 | 7.1 |
| *Keratella crossa* | <0.1 | 8.9 | | | | |
| *Notholca acuminata* | | | | | <0.1 | 3.6 |
| *Notholca squamula* | 12.5 | 1214.3 | 0.2 | 10.7 | | |
| *Nothalca foliacea* | 4.2 | 410.7 | 0.2 | 14.3 | <0.1 | 3.6 |
| *Notholca lapponica* | <0.1 | 8.9 | 0.1 | 3.6 | 0.1 | 3.6 |
| *Kellicottia longispina* | 4.1 | 401.8 | 8.0 | 492.9 | 7.7 | 696.4 |
| *Trichocerca* spp | | | | | 0.2 | 25.0 |
| *Trichocerca multicrinis* | <0.1 | 8.9 | 0.1 | 7.1 | <0.1 | 3.6 |
| *Trichocerca porcellus* | 0.6 | 53.6 | | | 0.5 | 42.9 |
| *Lepadella* sp | 0.5 | 44.6 | | | | |
| *Chromogaster ovalis* | | | | | 1.4 | 125.0 |
| *Asplanchna* spp | <0.1 | 8.9 | 8.7 | 535.7 | 0.7 | 60.7 |
| *Polyarthra* spp | 1.5 | 142.9 | 1.8 | 107.1 | 2.3 | 207.1 |
| *Polyarthra dolichoptera* | 0.6 | 53.6 | 8.7 | 532.1 | 25.9 | 2339.3 |
| *Polyarthra major* | <0.1 | 8.9 | | | 2.3 | 203.6 |
| *Polyarthra minor* | | | | | | |
| *Polyarthra vulgaris* | 1.7 | 160.7 | 0.6 | 39.3 | 14.6 | 1317.9 |
| *Synchaeta* spp | 48.3 | 4696.4 | 0.7 | 42.9 | | |
| *Synchaeta oblonga* | 10.5 | 1017.9 | | | 0.3 | 28.6 |
| *Synchaeta pectinata* | 8.9 | 866.1 | 5.9 | 364.3 | 3.2 | 289.3 |
| *Ploesoma* spp | <0.1 | 8.9 | | | 0.3 | 28.6 |
| *Ploesoma truncatum* | | | | | 7.4 | 664.3 |
| *Ploesoma triacanthum* | | | | | 0.1 | 7.1 |
| *Conochilus unicornis* | | | 59.0 | 3617.9 | 2.9 | 264.3 |
| *Bipalpus hudsoni* | | | 0.1 | 3.6 | | |
| | | 9732.1 | | 6135.7 | | 9025.2 |

## Table 3.3.2-2

## SPECIES COMPOSITION OF CRUSTACEAN ZOOPLANKTON ON JUNE 6, AUGUST 23, AND OCTOBER 4, 1979 AT BRUCE GS 'B'

| Taxa | Per Cent Composition | | | | | |
|---|---|---|---|---|---|---|
| | June 6 | | August 23 | | October 4 | |
| | % | Mean Density No/m$^3$ | % | Mean Density No/m$^3$ | % | Mean Density No/m$^3$ |
| Cladocera | | | | | | |
| *Leptodora kindtii* | | | <0.1 | 3.6 | <0.1 | 2.9 |
| *Diaphanosoma leuchtenbergianum* | | | | | <0.1 | 2.9 |
| *Holopedium gibberum* | <0.1 | 2.9 | 2.2 | 299.3 | 0.5 | 34.3 |
| *Daphnia retrocurva* | | | <0.1 | 2.1 | 0.5 | 40.7 |
| *Daphnia galeata mendotae* | | | 7.8 | 1060.7 | 1.7 | 129.3 |
| *Bosmina longirostris* | 0.3 | 13.6 | 2.0 | 267.1 | 1.0 | 79.3 |
| *Eubosmina coregoni* | <0.1 | 0.7 | 0.7 | 90.0 | 0.4 | 28.6 |
| *Chydorus* spp | <0.1 | 4.3 | | | | |
| *Polyphemus pediculus* | <0.1 | 0.7 | 1.0 | 137.9 | | |
| Calanoida | | | | | | |
| *Epischura lacustris* | | | | | <0.1 | 1.4 |
| *Limnocalanus macrurus* | <0.1 | 1.4 | | | | |
| *Eurytemora affinis* | | | | | <0.1 | 5.0 |
| *Diaptomus ashlandi* | 0.1 | 6.4 | <0.1 | 2.9 | <0.1 | 1.4 |
| *Diaptomus oregonensis* | <0.1 | 0.7 | | | <0.1 | 2.9 |
| *Diaptomus minutus* | 0.5 | 23.6 | 12.8 | 1750.7 | 2.0 | 150.7 |
| Calanoid nauplii | 82.5 | 3883.9 | 36.0 | 4928.6 | 21.0 | 1617.9 |
| Calanoid copepodids (CI-CV) | 9.7 | 457.1 | 20.9 | 2857.1 | 40.8 | 3144.5 |
| Cyclopoida | | | | | | |
| *Tropocyclops prasinus* | | | <0.1 | 10.7 | 0.4 | 30.7 |
| *Cyclops bicuspidatus thomasi* | 2.8 | 133.6 | 13.8 | 1882.9 | 26.2 | 2015.0 |
| *Mesocyclops edax* | | | <0.1 | 7.9 | 0.5 | 40.7 |
| Cyclopoid nauplii | 3.8 | 178.6 | 2.8 | 378.6 | 4.8 | 371.4 |
| | | 4707.5 | | 13 680.1 | | 7699.6 |

by Nauwerck were generally collected at locations further offshore than our study area.

The crustacean zooplankton occurred in highest abundance on August 23 (13 680/m$^3$) followed by October 4 (7700/m$^3$) and were least abundant on June 6 (4708/m$^3$) (Table 3.3.2-2). Calanoid copepod nauplii (larvae) made up the bulk (83%) of crustacean zooplankton numbers on June 6. On August 23 and October 4, the calanoid nauplii and copepodids (CI-CV) together constituted 57 and 62% of the total number of crustacean zooplankton respectively. Watson and Carpenter (1974) reported that about 31% of the crustacean zooplankton of Lake Huron consisted of calanoid copepods. *Diaptomus minutis* was the main calanoid species present on all three dates.

The cladocerans were found in highest abundances on August 23. Most cladocerans are summer species and their occurrence in the Great Lakes, with few exceptions, has generally been found to be limited to the summer months (Patalas, 1972; Watson, 1974). *Bosmina longirostris* was the main cladoceran species present on June 6 while *Daphnia galeata mendotae* was the main cladoceran present on August 23 and October 4. *Cyclops bicuspidatus thomasi* was the main cyclopoid copepod present on all three days. This species was found to be the most abundant cyclopoid copepod in a lakewide study conducted on Lake Huron in 1971 (Watson and Carpenter, 1974).

## Distribution of Rotifer and Crustacean Zooplankton Assemblages

One rotifer assemblage was identified on June 6. The main taxon in the assemblage was *Synchaeta* (see Table 3.3.2-1). Two assemblages were identified on August 23 (Table 3.3.2-3). The dominant species in assemblage 1 was *Conochilus unicornis* while the main taxa in assemblage 2 were *Keratella cochlearis*, *K. longispina* and *P. dolichoptera*. Assemblage 1 predominated over the study area while assemblage 2 occurred sporadically at a total of 5 locations primarily to the north of the Bruce GS 'B' discharge (Figure 3.3.2-1). Three assemblages were identified on October 4 (Table 3.3.2-4). *K. cochlearis* (33.5%) was the main species present in assemblage 1 followed by *P. dolichoptera*(25.9%) and *P. vulgaris* (14.6%). The main species present in assemblage 2 was *P. dolichoptera* (30%) followed by *K. cochlearis* (22%) and *Ploesoma truncatum* (19%) while *P. vulgaris* (46%) was the main species present in assemblage 3 followed by *P. dolichoptera* (32%). Assemblage 1 was the predominant assemblage present (Figure 3.3.2-2). Assemblage 2 only occurred sporadically at four spars while assemblage 3 only occurred at the 1.5 km offshore spar on the Bruce GS 'B' intake transect (X).

## Table 3.3.2-3

## MIA - ROTIFERS, AUGUST 23, 1979
## BRUCE GS 'B'

| Species | Assemblage 1 | Assemblage 2 |
|---|---|---|
| *Conochilus unicornis* | 55.2 | 11.7 |
| *Asplanchna* spp | 7.7 | 11.6 |
| *Polyarthra dolichoptera* | 12.3 | 20.2 |
| *Kellicottia longispina* | 9.3 | 20.6 |
| *Synchaeta pectinata* | 5.0 | 3.2 |
| *Keratella cochlearis* | 6.1 | 22.2 |
| *Polyarthra* spp | 2.1 | 2.9 |

## Table 3.3.2-4

## MIA - ROTIFERS, OCTOBER 4, 1979
## BRUCE GS 'B'

| Species | Assemblage 1 | Assemblage 2 | Assemblage 3 |
|---|---|---|---|
| *Keratella cochlearis* | 32.5 | 22.0 | 7.2 |
| *Polyarthra dolichoptera* | 24.9 | 29.7 | 31.5 |
| *Polyarthra vulgaris* | 13.6 | 11.9 | 46.0 |
| *Kellicottia longispina* | 8.3 | 8.2 | 3.6 |
| *Ploesoma truncatum* | 4.2 | 18.9 | 3.6 |
| *Synchaeta pectinata* | 3.0 | 2.9 | 0.0 |
| *Conochilus unicornis* | 3.4 | 0.6 | 1.8 |
| *Polyarthra* spp | 3.3 | 1.1 | 1.8 |
| *Polyarthra major* | 2.9 | 0.6 | 2.7 |
| *Chromogaster ovalis* | 1.2 | 2.3 | 0.0 |

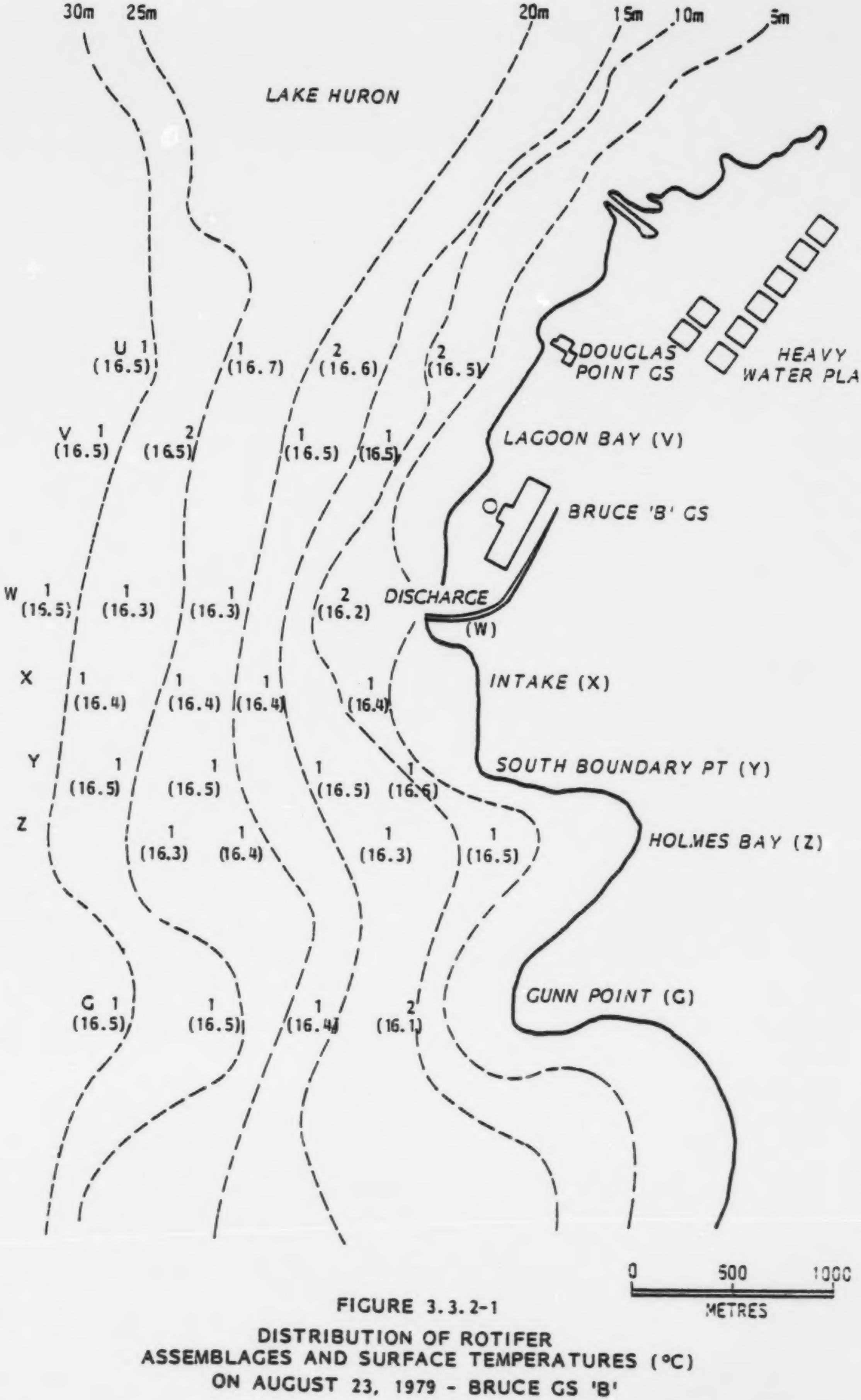

30m
25m
20m
15m
10m
5m
LAKE HURON
U 1 (16.5)
1 (16.7)
2 (16.6)
2 (16.5)
DOUGLAS POINT GS
HEAVY WATER PLANT
V 1 (16.5)
2 (16.5)
1 (16.5)
1 (16.5)
LAGOON BAY (V)
BRUCE 'B' GS
W 1 (15.5)
1 (16.3)
1 (16.3)
2 (16.2)
DISCHARGE
(W)
X 1 (16.4)
1 (16.4)
1 (16.4)
1 (16.4)
INTAKE (X)
Y 1 (16.5)
1 (16.5)
1 (16.5)
1 (16.6)
SOUTH BOUNDARY PT (Y)
Z 1 (16.3)
1 (16.4)
1 (16.3)
1 (16.5)
HOLMES BAY (Z)
G 1 (16.5)
1 (16.5)
1 (16.4)
2 (16.1)
GUNN POINT (G)
0
500
1000
METRES

FIGURE 3.3.2-1

DISTRIBUTION OF ROTIFER ASSEMBLAGES AND SURFACE TEMPERATURES (°C) ON AUGUST 23, 1979 - BRUCE GS 'B'

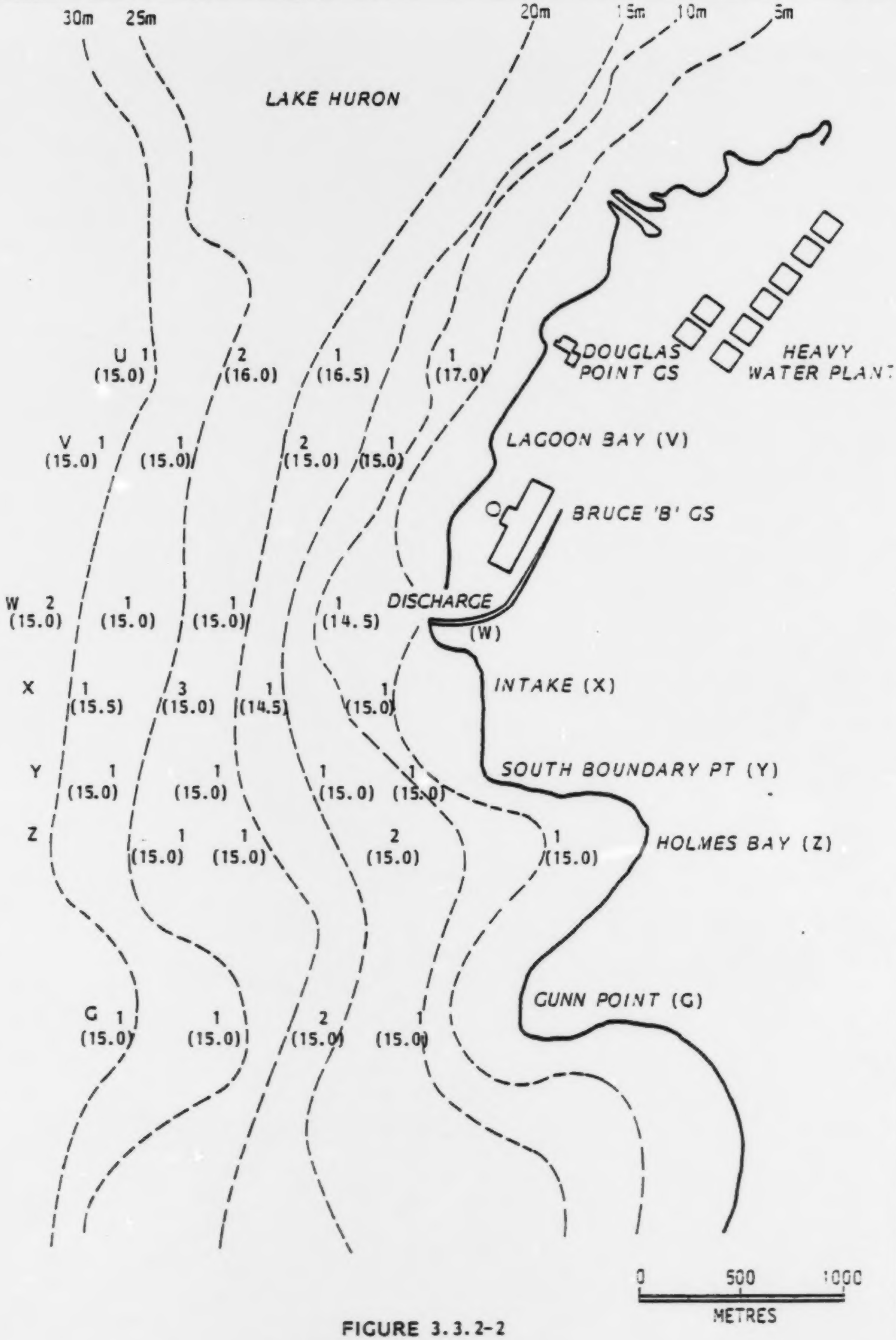

30m
25m
20m
15m
10m
5m
LAKE HURON
U 1 (15.0)
2 (16.0)
1 (16.5)
1 (17.0)
DOUGLAS POINT GS
HEAVY WATER PLANT
V 1 (15.0)
1 (15.0)
2 (15.0)
1 (15.0)
LAGOON BAY (V)
BRUCE 'B' GS
W 2 (15.0)
1 (15.0)
1 (15.0)
1 (14.5)
DISCHARGE
(W)
X 1 (15.5)
3 (15.0)
1 (14.5)
1 (15.0)
INTAKE (X)
Y 1 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
SOUTH BOUNDARY PT (Y)
Z 1 (15.0)
1 (15.0)
2 (15.0)
1 (15.0)
HOLMES BAY (Z)
G 1 (15.0)
1 (15.0)
2 (15.0)
1 (15.0)
GUNN POINT (G)
0
500
1000
METRES

FIGURE 3.3.2-2

DISTRIBUTION OF ROTIFER
ASSEMBLAGES AND SURFACE TEMPERATURES (°C)
ON OCTOBER 4, 1979 - BRUCE GS 'B'

The copepod nauplii (larvae) were not included in the Mutual Information Analysis performed on the crustacean zooplankton since they were not speciated and occurred in substantially higher numbers than the juveniles and adults. A single crustacean zooplankton assemblage dominated by the calanoid copepodites was identified on June 6. Two assemblages were identified on August 23 (Table 3.3.2-5). Assemblage 1 dominated by the calanoid copepodites was the predominant assemblage to the north and south of the study area. Assemblage 2 dominated by *C. bicuspidatus thomasi* occurred along three consecutive transects: Lagoon Bay, Bruce GS 'B' discharge and Bruce GS 'B' intake (Figure 3.3.2-3, V, W and X). A somewhat similar distribution of two phytoplankton assemblages were found on this day. Two assemblages, one dominated by calanoid copepodids (CI-CV) and another by *C. bicuspidatus thomasi* were again identified on October 4 (Table 3.3.2-6). Assemblage 1 occurred at all spars except the 1.5 km offshore spar at Douglas Point (U) and the 2.0 km offshore spar at Holmes Bay (Figure 3.3.2-4).

The distribution of the rotifer and crustacean zooplankton assemblages did not appear to be related to temperature (Figures 3.3.1-1, -2, -3).

On June 6 *S. pectinata* occurred in higher abundances at the two inshore spars on the Bruce GS 'B' intake transect (X) and the four spars on the South Boundary Point transect (Figure 3.3.2-5a, Y). *S. oblonga* also occurred in higher abundances at South Boundary Point and inshore (X) as well as inshore on the Bruce GS 'B' intake transect and the 1.0 km spar on the Holmes Bay transect (Figure 3.3.2-5b, Y). The density of *S. pectinata* ranged between 250 and 3750/m$^3$.while that of *S. oblonga* ranged between 250 and 6000/m$^3$. The density distribution of the unspeciated *Synchaeta*, however, was quite heterogeneous within the study area (Figure 3.3.2-5c). The density of the unspeciated *Synchaeta* ranged between 750 and 11 750/m$^3$. With the exception of the inshore spar on the Lagoon Bay transect, *N. squamula* generally occurred in higher abundances along the southern three transects (Figure 3.3.2-5d), South Boundary Point (Y), Holmes Bay (Z) and Gunn Point (G). Its density ranged from 250 to 4250/m$^3$.

The calanoid nauplii, calanoid copepodids (CI-CV) and *Cyclops bicuspidatus thomasi* (copepodids) all occurred in higher abundances in the southern half of the study area especially along the South Boundary Point (Y) and Gunn Point (G) transects (Figures 3.3.2-6a, -6b, -6c). The density of the calanoid nauplii ranged between 0 to 10 250/m$^3$ while that of the calanoid copepodids ranged between 40 and 1380/m$^3$. The density of *C. bicuspidatus thomasi* ranged between 20 and 230/m$^3$. The density distribution of the zooplankton on this day was not related to temperature (see Figure 3.3.1-1).

## Table 3.3.2-5

## CRUSTACEANS ZOOPLANKTON ASSEMBLAGES IDENTIFIED ON AUGUST 23, 1979

## BRUCE GS 'B'

| Species | Assemblage<br>1 | 2 |
|---|---|---|
| *Calanoid copepodite* | 35.2 | 15.3 |
| *Diacyclops bicuspidatus* | 24.3 | 65.0 |
| *Diaptomus minutus* | 17.1 | 4.0 |
| *Daphnia galeata* | 11.8 | 7.1 |
| *Holopedium gibberum* | 4.2 | 0.9 |
| *Bosmina longirostris* | 3.2 | 1.2 |
| *Polyphemus pediculus* | 3.0 | 5.4 |
| *Eubosmina coregoni* | 0.9 | 0.3 |

## Table 3.3.2-6

## CRUSTACEANS ZOOPLANKTON ASSEMBLAGES IDENTIFIED ON OCTOBER 4, 1979

## BRUCE GS 'B'

| Species | Assemblage<br>1 | 2 |
|---|---|---|
| *Calanoida copepodite* | 54.0 | 16.3 |
| *Cyclops bicuspidatus* | 36.4 | 75.4 |
| *Diaptomus minutus* | 2.2 | 1.3 |
| *Daphnia galeata* | 2.3 | 1.7 |
| *Bosmina longirostris* | 1.7 | 1.4 |

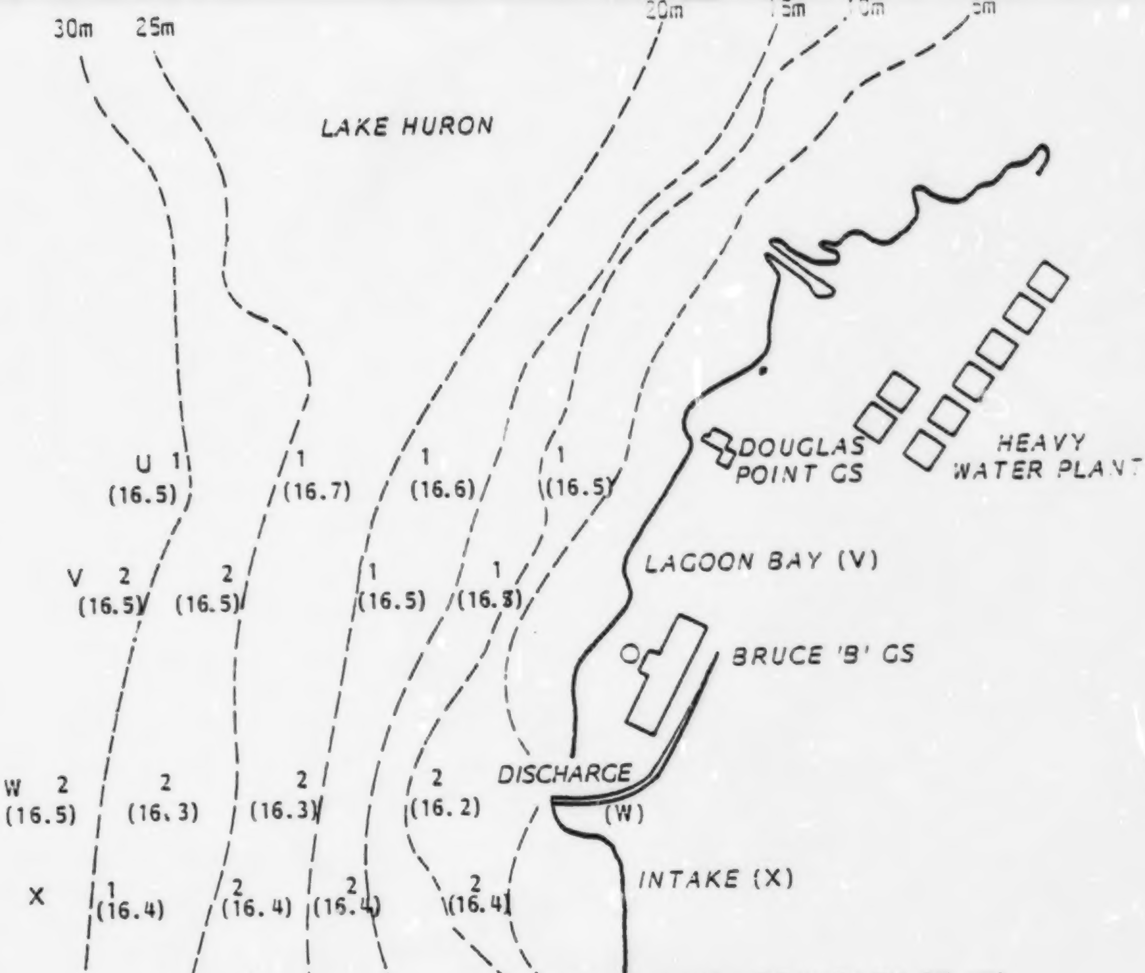

30m
25m
20m
15m
10m
5m
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
U 1 (16.5)
1 (16.7)
1 (16.6)
1 (16.5)
LAGOON BAY (V)
V 2 (16.5)
2 (16.5)
1 (16.5)
1 (16.3)
BRUCE 'B' GS
W 2 (16.5)
2 (16.3)
2 (16.3)
2 (16.2)
DISCHARGE (W)
X 1 (16.4)
2 (16.4)
2 (16.4)
2 (16.4)
INTAKE (X)
Y 1 (16.5)
1 (16.5)
1 (16.5)
1 (16.6)
SOUTH BOUNDARY PT (Y)
Z 1 (16.3)
1 (16.4)
1 (16.3)
1 (16.5)
HOLMES BAY (Z)
GUNN POINT (G)
G 1 (16.5)
1 (16.5)
1 (16.4)
1 (16.1)
0
500
1000
METRES

FIGURE 3.3.2-3

DISTRIBUTION OF CRUSTACEAN ASSEMBLAGES AND SURFACE TEMPERATURES (°C) ON AUGUST 23, 1979 - BRUCE GS 'B'

151224 RD

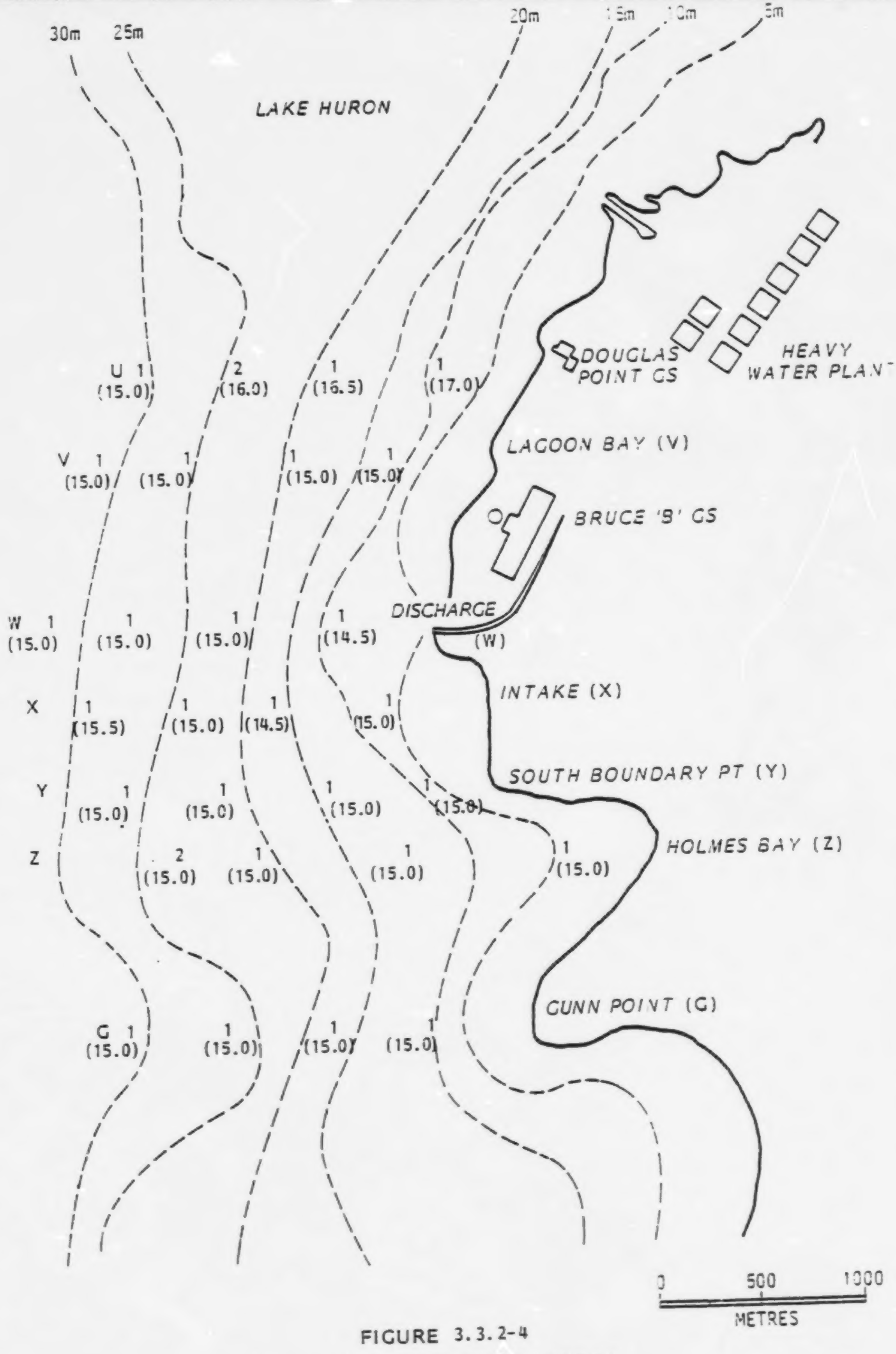

30m
25m
20m
15m
10m
5m
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE
(W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
U 1 (15.0)
2 (16.0)
1 (16.5)
1 (17.0)
V 1 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
W 1 (15.0)
1 (15.0)
1 (15.0)
1 (14.5)
X 1 (15.5)
1 (15.0)
1 (14.5)
1 (15.0)
Y 1 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
Z 2 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
G 1 (15.0)
1 (15.0)
1 (15.0)
1 (15.0)
0
500
1000
METRES

FIGURE 3.3.2-4

DISTRIBUTION OF ZOOPLANKTON
ASSEMBLAGES AND SURFACE TEMPERATURES (°C)
ON OCTOBER 4, 1979 - BRUCE GS 'B'

151225 RD

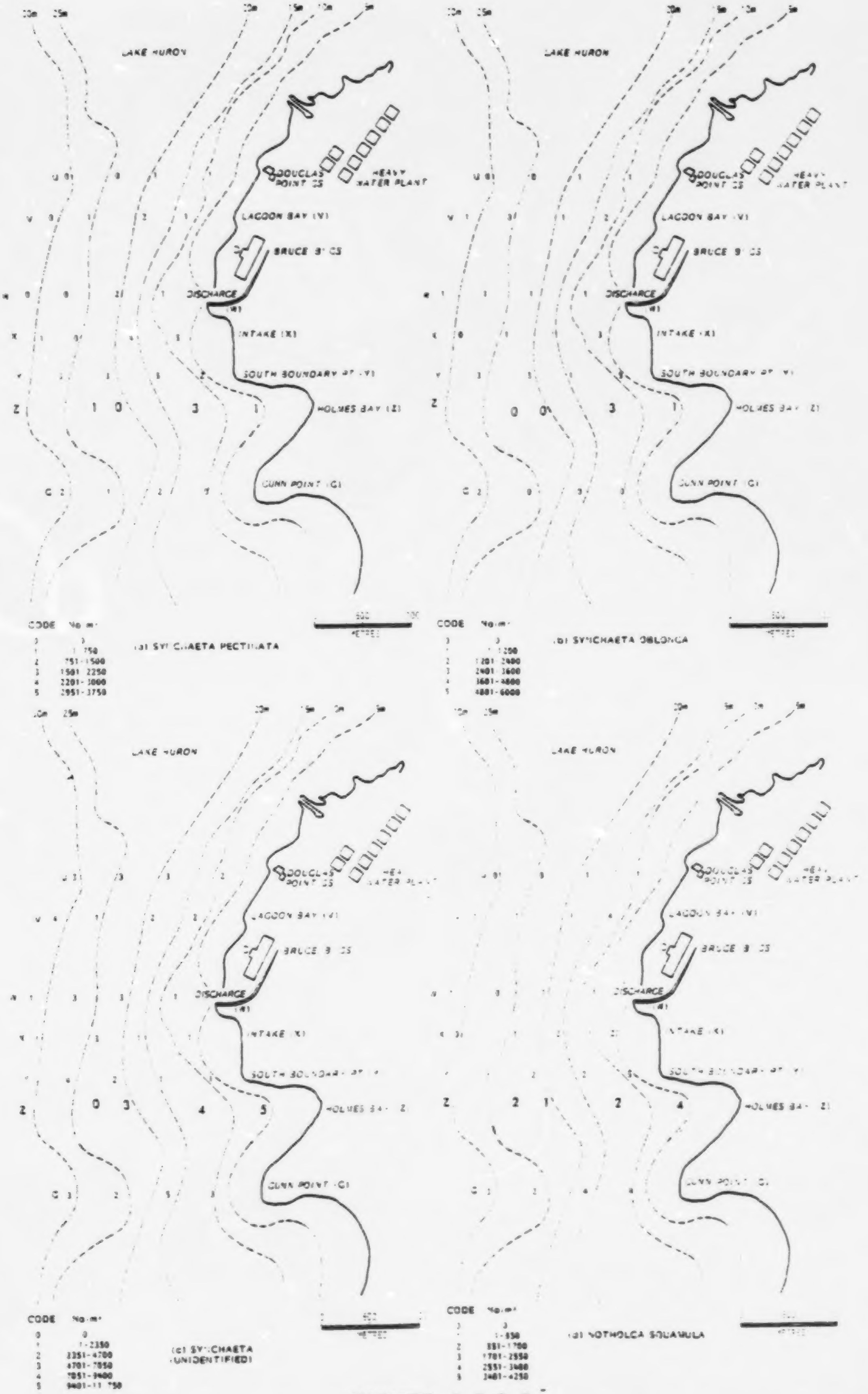
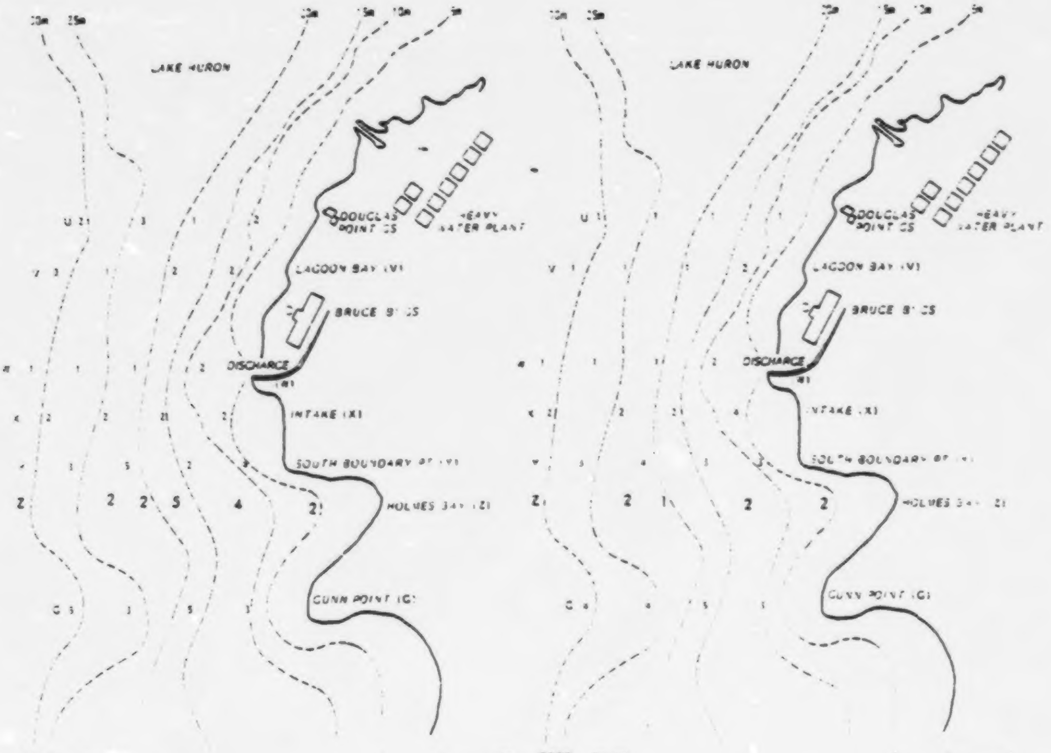

LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE (W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
500
METRES
CODE No/m³
0 0
1 1-750
2 751-1500
3 1501-2250
4 2201-3000
5 2951-3750
(a) SYNCHAETA PECTINATA
CODE No/m³
0 0
1 1-1200
2 1201-2400
3 2401-3600
4 3601-4800
5 4801-6000
(b) SYNCHAETA OBLONGA
CODE No/m³
0 0
1 1-2350
2 2351-4700
3 4701-7050
4 7051-9400
5 9401-11 750
(c) SYNCHAETA (UNIDENTIFIED)
CODE No/m³
0 0
1 1-850
2 851-1700
3 1701-2550
4 2551-3400
5 3401-4250
(d) NOTHOLCA SQUAMULA

FIGURE 3.3.2-5
DENSITY (No/m³) DISTRIBUTION OF (a) SYNCHAETA PECTINATA (b) SYNCHAETA OBLONGA, (c) SYNCHAETA (UNIDENTIFIED) AND (d) NOTHOLCA SQUAMULA ON JUNE 6, 1979 - BRUCE GS 'B'

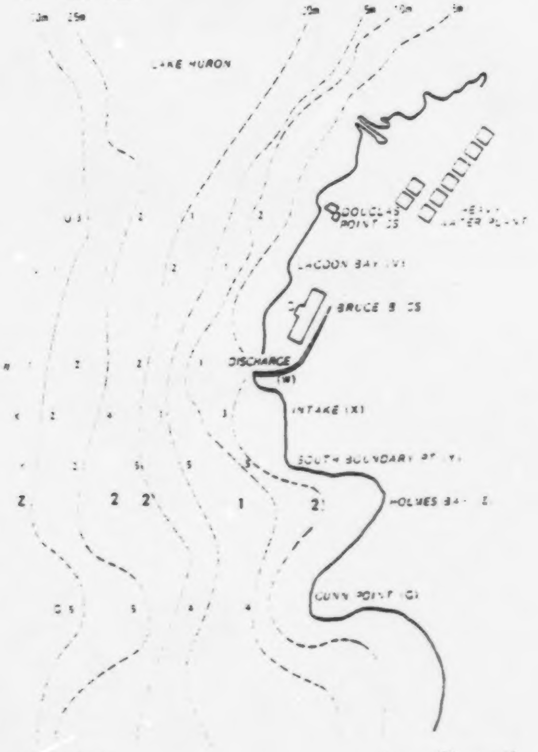

20m
25m
20m
15m
10m
5m
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE
(W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
METRES

| CODE | No/m³ |
|---|---|
| 0 | 0 |
| 1 | 1-2050 |
| 2 | 2051-4100 |
| 3 | 4101-6150 |
| 4 | 6151-8200 |
| 5 | 8201-10 250 |

(a) CALANOID NAUPLII

| CODE | No/m³ |
|---|---|
| 0 | 0 |
| 1 | 1-276 |
| 2 | 277-552 |
| 3 | 553-828 |
| 4 | 829-1104 |
| 5 | 1105-1380 |

(b) CALANOID COPEPODIDS


20m
25m
20m
15m
10m
5m
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE
(W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
METRES

| CODE | No/m³ |
|---|---|
| 0 | 0 |
| 1 | 1-64 |
| 2 | 65-128 |
| 3 | 129-192 |
| 4 | 193-256 |
| 5 | 257-320 |

(c) CYCLOPS BISCUSPIDATUS THOMASI

FIGURE 3.3.2-6

DENSITY (No/m³) DISTRIBUTION OF (a) CALANOID NAUPLII, (b) CALANOID COPEPODIDS AND (c) CYCLOPS BICUSPIDATUS THOMASI ON JUNE 6, 1979 - BRUCE GS 'B'

On August 23, the main zooplankton present were again more abundant in the southern portion of the study than on the northern part. Thus *C. unicornis*, the calanoid nauplii and copepodids (CI-CV), *D. minutus* (adults) and *D. galeata mendotae* were all found in higher abundances along the southern transects (Figure 3.3.2-7a, -7b, -7c, -7d, -8a). *C. unicornis* occurred in densities between 200 and 18 000/m , with highest densities found at the two inshore spars on the South Boundary Point transect (Y). Highest abundances of the calanoid nauplii, calanoid copepodids (CI-CV), *Diaptomus minutus* (adults) and *D. galeata mendotae* were found along the Gunn Point transect (G). The density of the calanoid nauplii ranged from 0 to 15 800/m$^3$, while that of the calanoid copepodids ranged from 180 to 20 640/m$^3$. The density of *D. minutus* ranged from 20 to 11 680/m$^3$ and *D. galeata mendotae* density ranged from 20 to 7200/m$^3$. *C. bicuspidatus thomasi* copepodids occurred in lower abundances along the northern transects at Douglas Point and Lagoon Bay (Figure 3.3.2-8b). Its density ranged from 400 to 4800/m$^3$. Again, the distribution of the main zooplankton taxa on this day did not appear to be related to temperature (see Figure 3.3.1-4). Temperatures on this day were slightly higher at the three inshore spars on the Douglas Point GS transect than in the remainder of the study area. The effluent from Little Sauble River, south of Gunn Point, may have affected the zooplankton densities at the southern limit of the study area on this day. A similar trend in the distribution of the phytoplankton on this day was not apparent.

On October 4 no consistent trends were apparent in the distribution of the rotifers and the crustacean zooplankton in the study area. The three main rotifer species, *K. cochlearis, P. dolichoptera* and *P. vulgaris* were all found to have a heterogeneous distribution (Figures 3.3.2-9a, -9b, -9c). The density of *K. cochlearis* ranged between 600 and 7600/m$^3$, that of *P. dolichoptera* was between 800 and 7200/m$^3$, while that of *P. vulgaris* ranged between 300 and 5100/m$^3$. The calanoid copepod nauplii and copepodids, and *C. bicuspidatus thomasi* were also heterogeneously distributed (Figures 3.3.2-10a, -10b, -10c). The density of the calanoid copepod nauplii ranged between 200 and 6000/m$^3$ while the density of the calanoid copepod copepodids ranged between 246 and 10 320/m$^3$. The density of *C. bicuspidatus thomasi* ranged from 460 to 4880/m$^3$.

### 3.3.3 Attached Algae

Thirteen attached algal taxa and six epiphytic algal taxa were identified at the Bruce GS 'B' sampling sites in 1979 (Table 3.3.3-1).

#### Shoreline Attached Algae

Three attached algal taxa were identified at shoreline locations on June 7 (Table 3.3.3-2). *Ulothrix zonata* (100%) was the dominant attached algae at five sampling locations. *Ulothrix zonata* (50%) was co-dominant with *Zygnema* (50%) at Holmes Bay while *Cladophora glomerata* (100%) was dominant at Lagoon Bay.

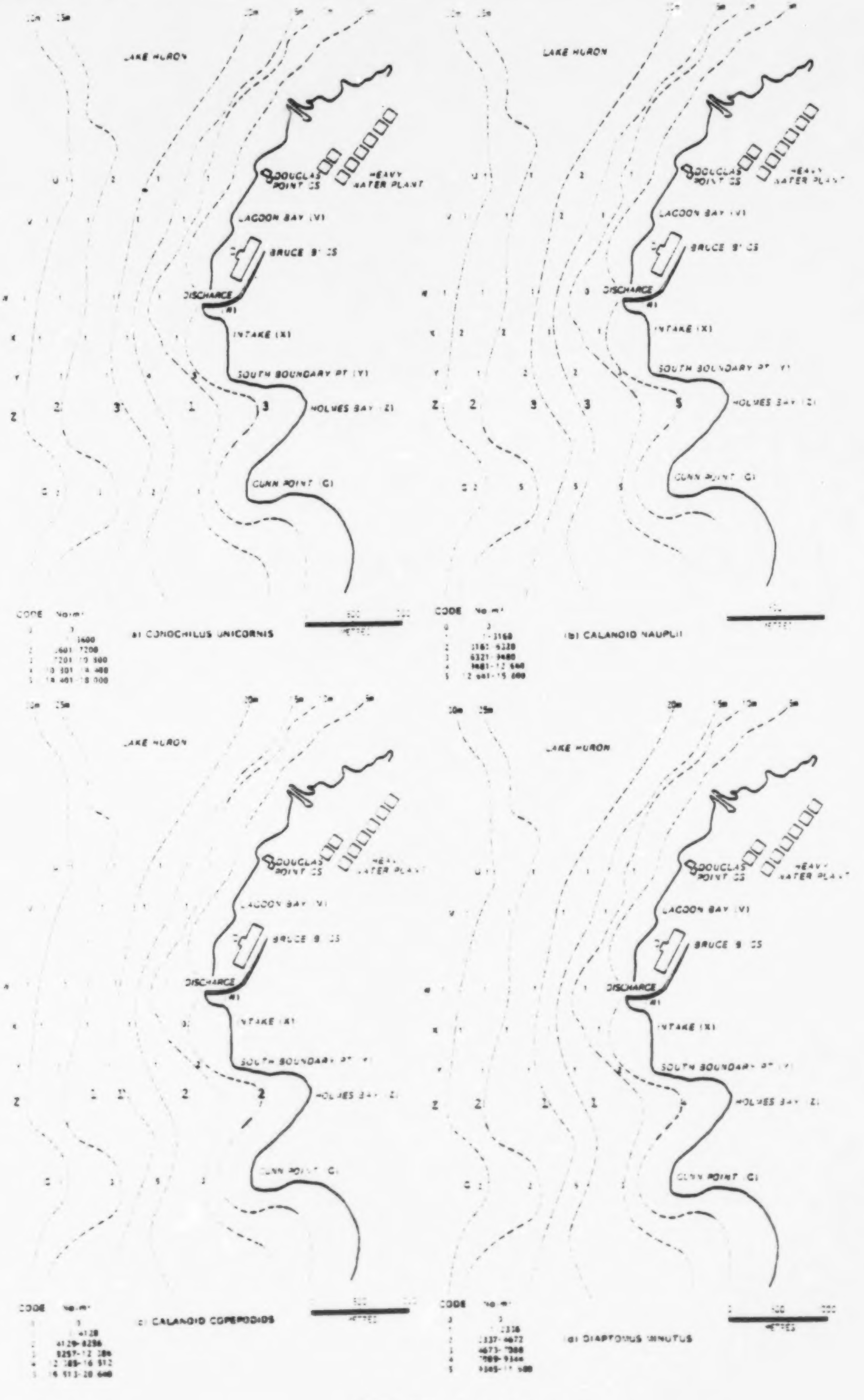

LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE
(W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
20m
15m
10m
5m
30m
25m
CODE No/m³
(a) CONOCHILUS UNICORNIS
0 0
1 1-3600
2 3601-7200
3 7201-10 800
4 10 801-14 400
5 14 401-18 000
(b) CALANOID NAUPLII
0 0
1 1-3160
2 3161-6320
3 6321-9480
4 9481-12 640
5 12 641-15 800
(c) CALANOID COPEPODIDS
0 0
1 1-4128
2 4129-8256
3 8257-12 384
4 12 385-16 512
5 16 513-20 640
(d) DIAPTOMUS MINUTUS
0 0
1 1-2336
2 2337-4672
3 4673-7008
4 7009-9344
5 9345-11 680
0
500
1000
METRES

FIGURE 3.3.2-7

DENSITY (No/$m^3$) DISTRIBUTION OF (a) CONOCHILUS UNICORNIS, (b) CALANOID NAUPLII, (c) CALANOID COPEPODIDS AND (d) DIAPTOMUS MINUTUS ON AUGUST 23, 1979 - BRUCE GS 'B'

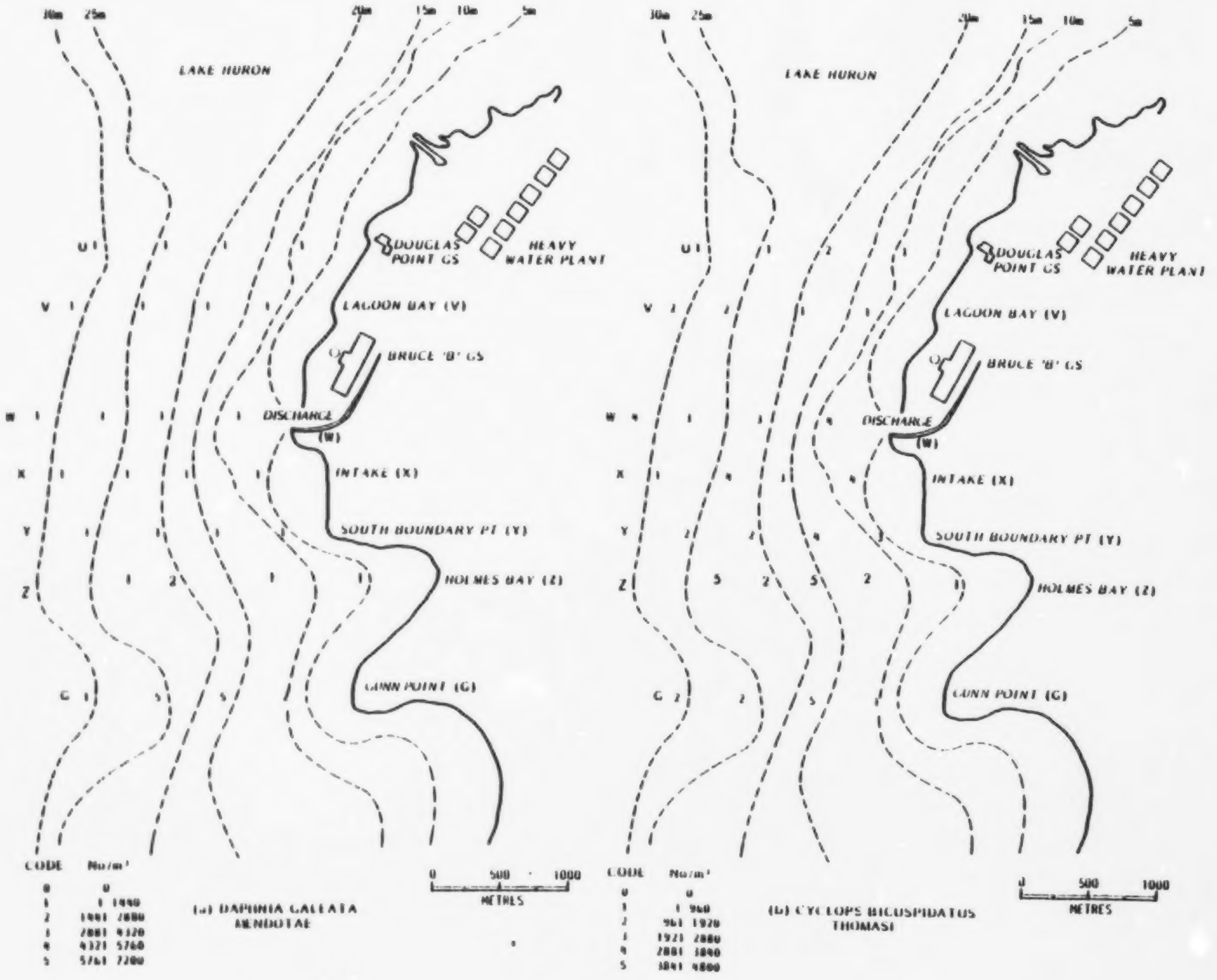

30m
25m
20m
15m
10m
5m
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE (W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
U
V
W
X
Y
Z
G
CODE No/m³
0 0
1 1 1440
2 1441 2880
3 2881 4320
4 4321 5760
5 5761 7200
(a) DAPHNIA GALEATA MENDOTAE
0 500 1000
METRES
CODE No/m³
0 0
1 1 960
2 961 1920
3 1921 2880
4 2881 3840
5 3841 4800
(b) CYCLOPS BICUSPIDATUS THOMASI
0 500 1000
METRES

FIGURE 3.3.2-8

DENSITY (No/m³) DISTRIBUTION OF (a) DAPHNIA GALEATA MENDOTAE AND
(b) CYCLOPS BICUSPIDATUS THOMASI ON AUGUST 23, 1979 - BRUCE GS 'B'

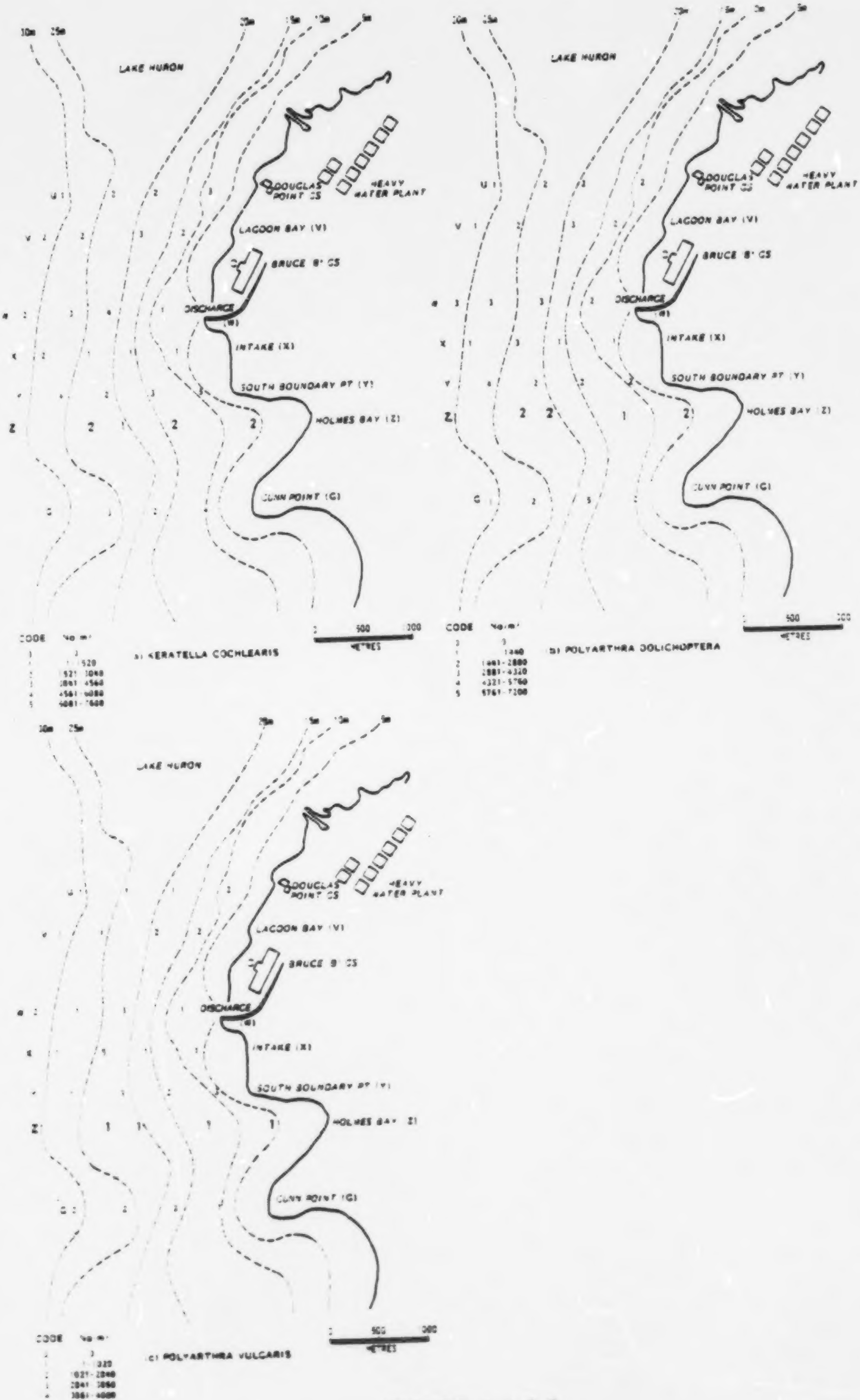

30m
25m
20m
15m
10m
5m
LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE
(W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
0
500
1000
METRES
CODE
No/m³
(a) KERATELLA COCHLEARIS
0
1 - 1520
1521 - 3040
3041 - 4560
4561 - 6080
6081 - 7600
(b) POLYARTHRA DOLICHOPTERA
0
1 - 1440
1441 - 2880
2881 - 4320
4321 - 5760
5761 - 7200
(c) POLYARTHRA VULGARIS
0
1 - 1020
1021 - 2040
2041 - 3060
3061 - 4080
4081 - 5100

FIGURE 3.3.2-9

DENSITY (No/m³) DISTRIBUTION OF (a) KERATELLA COCHLEARIS (b) POLYARTHRA DOLICHOPTERA AND (c) POLYARTHRA VULGARIS ON OCTOBER 4, 1979 - BRUCE GS 'B'

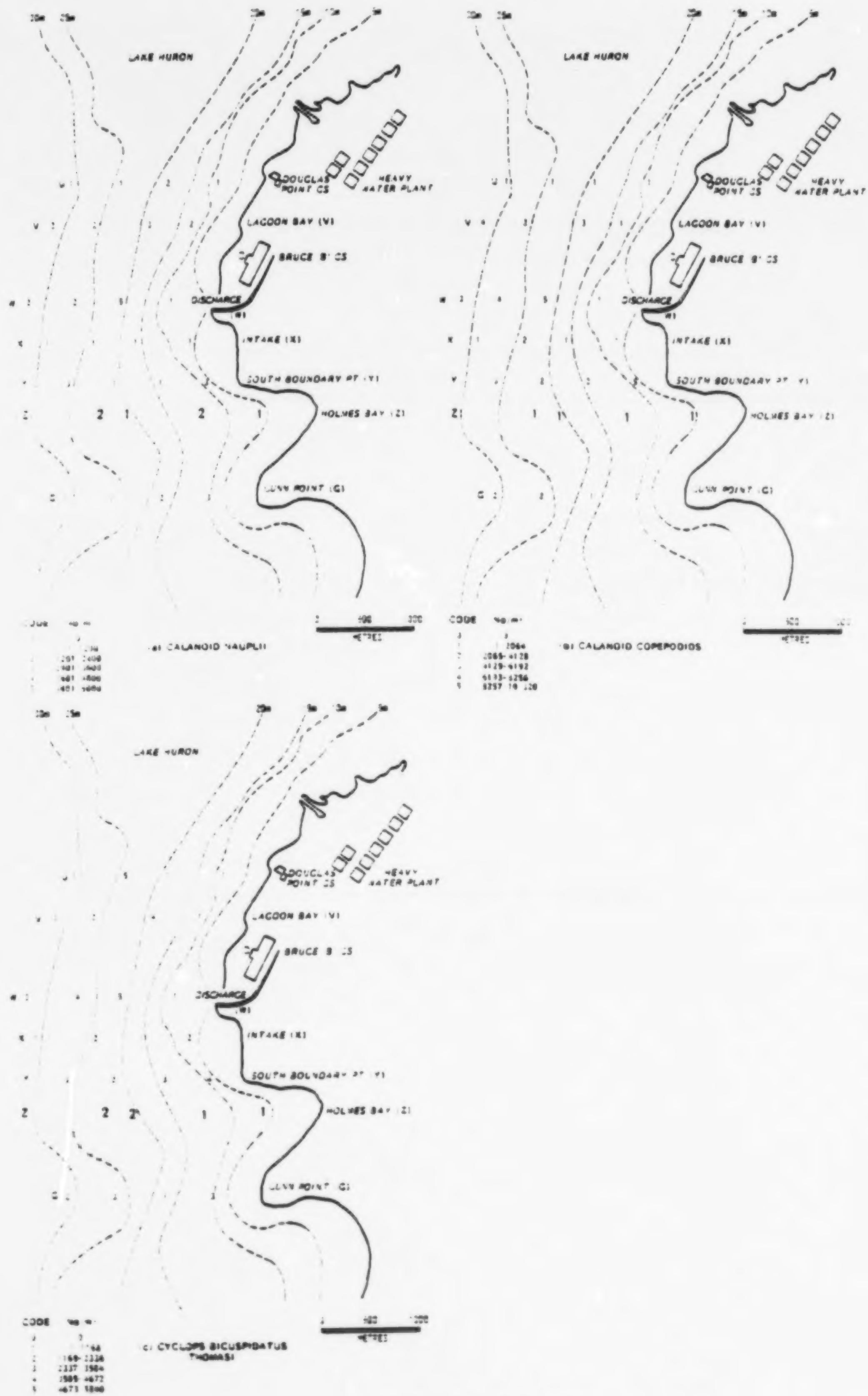

LAKE HURON
DOUGLAS POINT GS
HEAVY WATER PLANT
LAGOON BAY (V)
BRUCE 'B' GS
DISCHARGE (W)
INTAKE (X)
SOUTH BOUNDARY PT (Y)
HOLMES BAY (Z)
GUNN POINT (G)
CODE No/m³
(a) CALANOID NAUPLII
(b) CALANOID COPEPODIDS
2065-4128
4129-6192
6193-8256
8257-10 320
(c) CYCLOPS BICUSPIDATUS THOMASI
1169-2336
2337-3504
3505-4672
4673-5840
METRES

FIGURE 3.3.2-10

DENSITY (No/m³) DISTIRBUTION OF (a) CALANOID NAUPLII
(b) CALANOID COPEPODIDS AND (c) CYCLOPS
BICUSPIDATUS THOMASI ON OCTOBER 4, 1979
BRUCE GS 'B'

## Table 3.3.3-1

## ATTACHED AND EPIPHYTIC ALGAL TAXA
## BRUCE GS 'B' - 1979

| Attached Algae | Epiphytes |
|---|---|
| *Chaetonema* sp | *Cocconeis* spp |
| *Cladophora glomerata* | *Cymbella* spp |
| *Cladophora* sp | *Gomphonema* spp |
| *Dicothrix* sp | *Pennales* spp |
| *Lyngbya* sp | *Rhoicosphenia curvata* |
| *Mougeotia* sp | *Synedra* spp |
| *Oedogonium* sp | |
| *Pithophora* spp | |
| *Protoderma* sp | |
| *Spirogyra* sp | |
| *Ulothrix zonata* | |
| *Ulothrix* sp | |
| *Zygnema* sp | |

## Table 3.3.3-2

## PER CENT COMPOSITION SHORELINE ATTACHED ALGAE
## BRUCE GS 'B' - 1979

| Attached Algae | Douglas Point | | | Lagoon Bay | | | Bruce 'B' Discharge | | | Bruce 'B' Intake | | | South Boundary | | | Holmes Bay | | | Gunn Point | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | A | O | J | A | O | J | A | O | J | A | O | J | A | O | J | A | O | J | A | O |
| *Chaetonema* sp | | | | | | | | | | | | | | | | | | | | 33 | 67 |
| *Cladophora glomerata* | | | 1 | 100 | | | | | | | | 100 | | | | | | | | | |
| *Cladophora* sp | | | | | | | | | | | | | | | | | | 25 | | | |
| *Dicothrix* sp | | | | | | | | | | | | | | | | | | 33 | | 1 | |
| *Lyngbya* sp | | 25 | | | | | | | | | | | | | | | | | | | |
| *Mougeotia* sp | | 75 | 96 | | | 73 | | | | | | | | | 100 | | | 23 | | | 30 |
| *Oedogonium* sp | | | 1 | | | | | | | | | | | | | | | | | | |
| *Pithophora* spp | | | 1 | | | | | | | | | | | | | | | | | | |
| *Protoderma* sp | | | | | | | | | | | | | | | | | | | | 28 | |
| *Spirogyra* sp | | | | | | 3 | | | | | | | | | | | | | | | |
| *Ulothrix zonata* | 100 | | | | | 18 | 100 | | | 100 | | | 100 | | | 50 | | | 100 | 38 | 3 |
| *Ulothrix* sp | | | | | | 2 | | | | | | | | | | | | 1 | | | |
| *Zygnema* sp | | | 1 | | | 3 | | | | | | | | | | 50 | | 17 | | | |
| **Epiphytes** | | | | | | | | | | | | | | | | | | | | | |
| *Cocconeis* spp | | | | 60 | | | | | | | | | | | | | | 15 | | | |
| *Cymbella* spp | | | 75 | | | 100 | | | 25 | | | 50 | | | 75 | 45 | | | | 25 | 97 |
| *Gomphonema* spp | | | | | | | 100 | | 75 | | | 50 | | | 25 | 5 | | 65 | | 25 | |
| *Pennales* spp | | | 25 | | | | | | | | | | | | | | | 20 | | 50 | 3 |
| *Rhoicosphenia curvata* | | | | 40 | | | | | | | | | | | | | | | | | |
| *Synedra* spp | | | | | | | | | | | | | | | | 50 | | | 100 | | |

J - June 7
A - August 9
O - October 4

No attached algae were located at the shoreline sampling sites from Lagoon Bay south to Holmes Bay on August 9. *Mougeotia* (75%) was dominant at Douglas Point while *Ulothrix zonata* (38%), *Chaetonema* (33%) and *Protoderma* (28%) were co-dominant at Gunn Point.

Eleven attached algal taxa were identified on the October 4 sampling date. *Mougeotia* was dominant at Douglas Point (96%), Lagoon Bay (73%) and South Boundary (100%). *Cladophora glomerata* was dominant at the Bruce GS 'B' intake (100%) while *Chaetonema* was dominant at Gunn Point (67%). *Dicothrix* (33%), *Cladophora* sp (25%) and *Mougeotia* (23%) were co-dominant at Holmes Bay. No attached algae were present at the Bruce GS 'B' discharge in October.

A general temporal comparison of the shoreline attached algae indicated a shift in species composition at most locations from *Ulothrix zonata* on June 7 to *Mougeotia* on October 4 with an absence of shoreline attached algae on August 9. The attached algal community at Douglas Point shifted from 100% *Ulothrix zonata* on June 7 to 75% and 96% *Mougeotia* on August 9 and October 4, respectively. *Ulothrix zonata* (100%) was dominant at Gunn Point on June 7. The attached algal community on August 9 consisted of *Ulothrix zonata* (38%), *Chaetonema* (33%), *Protoderma* (28%) and *Dicothrix* (1%). On October 4 *Chaetonema* comprised 67% of the attached algal community while *Mougeotia* formed 30%.

### 3 m Attached Algae

No attached algae were present on June 7 at any of the 3 m sampling locations, nor on August 9 at Douglas Point, Lagoon Bay, South Boundary, Holmes Bay and Gunn Point (Table 3.3.3-3). *Mougeotia* comprised 100% of the samples at Bruce GS 'B' discharge and Bruce GS 'B' intake on August 9.

No attached algal taxa were present at the South Boundary, Holmes Bay, and Gunn Point 3 m sampling sites on October 4. *Mougeotia* comprised 100% of the attached algal community at Douglas Point and 50% at Lagoon Bay. *Cladophora glomerata* (50%) was co-dominant with *Mougeotia* at Lagoon Bay. *Mougeotia* (60%) was associated with *Spirogyra* (40%) at the Bruce GS 'B' discharge while *Mougeotia* (40%) was co-dominant with *Chaetonema* (40%) at the Bruce GS 'B' intake.

### Epiphytes

The epiphytes identified in the attached algal samples are presented in Tables 3.3.3-2, -3. No epiphytes were identified on June 7 at Douglas Point, the Bruce 'B' intake and South Boundary shoreline sites. *Synedea* (100%) was dominant at Gunn Point and co-dominant (50%) with *Cymbella* (45%) at Holmes Bay. *Gomphonema* (100%) was the dominant June 7 shoreline epiphyte identified at the Bruce 'B' discharge while *Cocconeis* (60%) and *Rhoicosphenia curvata* (40%) were identified at Lagoon Bay. No epiphytes were identified in the 3 m June 7 attached algal samples.

## Table 3.3.3-3

## PER CENT COMPOSITION 3 m ATTACHED ALGAE BRUCE GS 'B' - 1979

| Attached Algae | Douglas Point | | | Lagoon Bay | | | Bruce 'B' Discharge | | | Bruce 'B' Intake | | | South Boundary | | | Holmes Bay | | | Gunn Point | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | A | O | J | A | O | J | A | O | J | A | O | J | A | O | J | A | O | J | A | O |
| *Chaetonema* sp | | | | | | | | | | | | 40 | | | | | | | | | |
| *Cladophora glomerata* | | | | | | 50 | | | | | | | | | | | | | | | |
| *Mougeotia* sp | | | 100 | | | 50 | | 100 | 60 | | 100 | 40 | | | | | | | | | |
| *Spirogyra* sp | | | | | | | | | 40 | | | 15 | | | | | | | | | |
| *Ulothrix zonata* | | | | | | | | | | | | 5 | | | | | | | | | |
| **Epiphytes** | | | | | | | | | | | | | | | | | | | | | |
| *Cymbella* spp | | | 50 | | | 75 | | | | | | | | | | | | | | | |
| *Gomphonema* spp | | | 50 | | | 15 | | 100 | | | | | | | | | | | | | |
| *Pennales* spp | | | | | | 10 | | | | | 100 | 100 | | | | | | | | | |

J - June 7

A - August 9

O - October 4

Shoreline epiphytes were identified only at Gunn Point on August 9. Pennales (50%), *Cymbella* (25%) and *Gomphonema* (25%) were identified in the Gunn Point sample. Pennales (100%) and *Gomphonema* (100%) were identified at the Bruce GS 'B' intake 3 m and the Bruce GS 'B' discharge 3 m respectively on August 9. Epiphytes were not identified at the remaining 5 sampling sites.

Epiphytes were recorded at all shoreline sampling locations on October 4. *Cymbella* was the dominant epiphyte identified at Douglas Point (75%), Lagoon Bay (100%), South Boundary (75%) and Gunn Point (97%) shoreline sites. *Gomphonema* was dominant at the Bruce GS 'B' discharge (75%) and Holmes Bay (65%) and co-dominant (50%) with *Cymbella* (50%) at the Bruce GS 'B' intake. *Cymbella* (75%) was the dominant 3 m epiphyte at Lagoon Bay on October 4 and was co-dominant (50%) with *Gomphonema* (50%) at Douglas Point. *Pennales* (100%) were the dominant epiphyte at the Bruce 'B' intake (3 m). No epiphytes were identified at the 3 m depth at the Bruce 'B' discharge, South Boundary, Holmes Bay and Gunn Point on October 4.

The mean attached algal biomass (ash-free dry weight, gm/m$^2$ ±1SD) data are presented in Table 3.3.3-4 while the attached algal sample dry and ash weights are reported in Appendix K.

Shoreline Biomass

Attached algal biomass (ash-free dry weight) was highest on June 7 when a mean biomass level of 28.3 gm/m$^2$ was recorded for the seven sampling locations while August 9 biomass was relatively low ($\bar{x}$ = 10.0 gm/m$^2$). On August 9 no attached algae were located at any of the sampling locations from Lagoon Bay south to Holmes Bay.

Attached algal biomass was highest along the Bruce GS 'B' intake transect ($\bar{x}$ = 50.0 gm/m$^2$) while the lowest mean biomass was determined along the Bruce GS 'B' discharge transect (2.5 gm/m$^2$).

3 m Biomass

The mean 3 m sample biomass (ash-free dry weight) levels ranged from a low of 4.0 gm/m$^2$ on August 9 to a high of 9.9 gm/m$^2$ on October 4 (Table 3.3.3-4).

The 3 m algal biomass was lowest at Gunn Point ($\bar{x}$ = 2.0 gm/m$^2$) and South Boundary ($\bar{x}$ = 6.0 gm/m$^2$). The mean algal biomass at all other 3 m study locations ranged from 11.5 gm/m$^2$ at Holmes Bay to 15.0 gm/m$^2$ at the Bruce 'B' discharge.

### 3.3.4 Zoobenthos

A total of 1500 organisms were collected, yielding sixty taxa within seven major taxonomic groups (Table 3.3.4-1, Appendix L). Overall, 97 per cent of the organisms collected belonged to the Oligochaeta or Diptera. The Oligochaeta dominated the data set

## Table 3.3.3-4

### ATTACHED ALGAL BIOMASS (ASH-FREE DRY WEIGHT) ($gm/m^2 \pm 1SD$)
### BRUCE GS 'B' - 1979

| Date | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point | Monthly Mean |
|---|---|---|---|---|---|---|---|---|
| **Shoreline** | | | | | | | | |
| June 7 | 35 ±17 | 42 ±32 | 2 ±1 | 51 ±7 | 43 ±12 | 2 ±3 | 23 ±2 | 28.3 |
| August 9 | 11 ±5 | NA | NA | NA | NA | NA | 9 ±12 | 10.0 |
| October 4 | 7 ±3 | 21 ±8 | 3 ±<1 | 49 ±38 | 18 ±5 | 11 ±8 | 2 ±1 | 15.9 |
| Location Mean | 17.7 | 31.5 | 2.5 | 50.0 | 30.5 | 6.5 | 17.0 | |
| **3 m** | | | | | | | | |
| June 7 | 9 ±2 | 11 ±2 | 5 ±4 | 7 ±1 | 5 ±1 | 11 ±7 | 1 ±<1 | 7.0 |
| August 9 | 4 ±2 | 2 ±2 | 4 ±1 | 8 ±1 | 4 ±2 | 4 ±2 | 2 ±2 | 4.0 |
| October 4 | 13 ±3 | 13 ±2 | 21 ±3 | 10 ±3 | 3 ±2 | 8 ±4 | <1 ±<1 | 9.9 |
| Location Mean | 13.0 | 13.0 | 15.0 | 12.5 | 6.0 | 11.5 | 2.0 | |

NA - No Algae

## Table 3.3.4-1

### SUMMARY OF THE ZOOBENTHOS COMMUNITY BY THE MAJOR TAXONOMIC GROUPS COLLECTED AT BRUCE GS "B", JUNE AND OCTOBER 1979

| Major Taxa | Number of Taxa | Total Number of Individuals | Percentage |
|---|---|---|---|
| Oligochaeta | 9 | 976 | 65.8 |
| Diptera | 37 | 470 | 31.6 |
| Mollusca | 7 | 25 | 1.8 |
| Acarina | 1 | 18 | 1.2 |
| Trichoptera | 3 | 6 | 0.4 |
| Amphipoda | 2 | 4 | 0.3 |
| Ephemeroptera | 1 | 1 | 0.7 |
| Total | 60 | 1500 | 100.0 |

accounting for 65 per cent of the organisms collected. The Diptera were second in numerical importance accounting for 31 per cent but dominated in number of species (37) present. These taxa primarily belonged to Chironomidae. The Oligochaeta were represented by the families Lumbriculidae, Tubificidae and Naidae. In total, nine individual taxa belonging to these families were identified.

Taxa comprising at least one per cent of the total benthos collected are listed in Table 3.3.4-2. These taxa included Oligochaeta, Chrionomidae and the Acarina. *Nais pardalis* dominated the data set, accounting for 52 per cent of the organisms collected. All other taxa collected occurred at much lower levels. The chirnomid subfamily Orthocladiinae (9.5%) and Oligochaeta family Tubificidae (7.3%) were next in order of decreasing abundance. These two taxa were represented by immature organisms which could not be speciated. Other taxa in this group which were identified to at least the generic level were the Oligochaetes *Nais* spp, and *Nais* variabilis and the chironomid taxa Thienemannimyia group, *Pseudosmittia* spp, *Micropsectra (Paratanytarsus)* spp, Heterotrissocladius spp, Tanytarsus spp and Orthocladius obumbratus.

## Density

Densities during June ranged from 31 $m^2$ to 774 $m^2$ (Table 3.3.4-3). The overall site mean was 225 $m^2$. At this time, transect means ranged from 85 $m^2$ along the Bruce GS 'B' discharge to 341 $m^2$ at both Lagoon Bay and Holmes Bay. Among transects no consistent trend of abundance with depth was apparent, however, highest average abundances were observed at the 1 m depth.

Densities observed during October were considerably higher than those observed during June. Individual abundances ranged from 62 $m^2$ to 4558 $m^2$ and averaged 1438 $m^2$ over the entire site. Transect means ranged from 403 $m^2$ at Holmes Bay to 2899 $m^2$ at Douglas Point. Notably, densities at Lagoon Bay and Holmes Bay, which were the highest transect means during June, did not increase as dramatically as other transects during October and on the average were the lowest observed along any transect at this time.

## Richness

Number of taxa collected during June ranged from 1 to 10 from individual samples, and averaged 4.1 over the entire site (Table 3.3.4-4). Transect means ranged from a low of 2 at the Bruce 'B' discharge to 6 at Holmes Bay. Among transects, no consistent pattern was evident with depth. The average number of taxa observed at depths 1 m, 3 m and 12 m ranged from 4.3 to 4.9, while an average of 2.7 was noted at 7 m.

## Table 3.3.4-2

PER CENT COMPOSITION BY THE NUMBER OF TAXA CONTRIBUTING GREATER THAN 1% TO THE TOTAL DATA SET
BRUCE GS 'B' - JUNE AND OCTOBER 1979

| Taxa | Avg Density #/m² | Total Number | Percentage | Cumulative Per cent |
|---|---|---|---|---|
| *Nais pardalis* | 431 | 779 | 51 | 51 |
| Orthocladiinae | 79 | 143 | 9 | 61 |
| Tubificidae | 60 | 110 | 7 | 68 |
| *Thienemannimyia* group | 38 | 65 | 4 | 73 |
| *Nais* spp | 30 | 55 | 3 | 76 |
| *Pseudosmittia* spp | 26 | 47 | 3 | 79 |
| *Micropsectra (Paratanytarsus)* spp | 15 | 28 | 1 | 81 |
| *Heterotrissocladius* spp | 12 | 23 | 1 | 83 |
| *Tanytarsus* spp | 12 | 23 | 1 | 84 |
| *Nais variablis* | 12 | 22 | 1 | 86 |
| *Orthocladius obumbratus* | 11 | 20 | 1 | 87 |
| Acarina | 10 | 18 | 1 | 88 |

## Table 3.3.4-3

### SPATIAL-TEMPORAL DISTRIBUTION OF THE NUMBER OF INDIVIDUALS COLLECTED BRUCE GS "B" - 1979

| June | Douglas Point | Lagoon Bay | Bruce "B" Discharge | Bruce "B" Intake | South Boundary | Holmes Bay | Gunn Pt. | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| 1 m | 372.1 | 774.1 | 31.0 | 155.0 | 372.1 | 372.1 | 248.1 | 332.1 |
| 3 m | 341.1 | 279.1 | 186.0 | 279.1 | 93.0 | 558.1 | 217.0 | 279.0 |
| 7 m | 155.0 | 124.0 | 31.0 | 93.0 | 31.0 | 31.0 | 248.1 | 101.9 |
| 12 m | 93.0 | 187.0 | 93.0 | 248.1 | 248.1 | 403.1 | 31.0 | 186.2 |
| $\bar{x}$ | 229.0 | 341.0 | 85.2 | 193.8 | 186.0 | 341.0 | 186.0 | |

| October | Douglas Point | Lagoon Bay | Bruce "B" Discharge | Bruce "B" Intake | South Boundary | Holmes Bay | Gunn Point | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| 1 m | 4558.1 | 1364.3 | 4217.0 | 4279.0 | 1333.3 | 775.2 | 248.1 | 2396.4 |
| 3 m | 2263.5 | 1023.2 | 713.2 | 1271.3 | 2139.5 | 620.1 | 434.1 | 1209.3 |
| 7 m | 3224.8 | 62.0 | 1922.5 | 1798.4 | 1209.3 | 93.0 | 1054.3 | 1337.7 |
| 12 m | 1550.4 | 93.0 | 744.2 | 1116.2 | 1488.4 | 124.0 | 527.1 | 806.9 |
| $\bar{x}$ | 2899.2 | 635.6 | 1899.2 | 2116.2 | 1542.6 | 403.0 | 565.9 | |

## Table 3.3.4-4

## SPATIAL-TEMPORAL DISTRIBUTION OF THE NUMBER OF TAXA COLLECTED BRUCE GS 'B' - 1979

| June | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point | |
|---|---|---|---|---|---|---|---|---|
| 1 m | 5 | 6 | 1 | 4 | 5 | 8 | 5 | 4 |
| 3 m | 4 | 5 | 4 | 5 | 2 | 5 | 5 | 4 |
| 7 m | 4 | 4 | 1 | 3 | 1 | 1 | 5 | 2 |
| 12 m | 3 | 5 | 2 | 4 | 7 | 10 | 1 | 4 |
| $\bar{x}$ | 4 | 5 | 2 | 4 | 3.75 | 6 | 4 | $\bar{x}$=4.12 |

| Oct | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point | |
|---|---|---|---|---|---|---|---|---|
| 1 m | 11 | 7 | 9 | 7 | 6 | 11 | 4 | 7 |
| 3 m | 7 | 6 | 10 | 7 | 9 | 6 | 7 | 7 |
| 7 m | 11 | 2 | 13 | 11 | 11 | 3 | 10 | 8 |
| 12 m | 14 | 3 | 6 | 11 | 13 | 3 | 6 | 8 |
| $\bar{x}$ | 10.75 | 4.5 | 9.5 | 9.0 | 9.75 | 5.75 | 6.75 | $\bar{x}$=8.00 |

Number of taxa collected during October were higher than observed during June. During October the number per sample ranged from 2 to 14 and averaged 8 over the site. Transect means ranged from 4.5 at Lagoon Bay to 10.8 at Douglas Point. Among transects no consistent trend was apparent with depth. Overall depth means ranged from 7.4 to 8.7 taxa.

## Diversity Indices

As noted for number of taxa and density, diversity indices also increased from June to October. During June, diversity indices ranged from 0 to 3.24 and averaged 1.61 (Table 3.3.4-5). Transect means ranged from 0.68 along the Bruce GS 'B' discharge to 2.00 at Holmes Bay. Depth means ranged from 1.07 to 1.8. During October diversity indices ranged from a low of 1.00 to 3.20 averaging 1.97. Transect means ranged from 1.32 at Lagoon Bay to 2.28 at Gunn Point. Depth means averaged 1.54 at 1 m and increased with depth to 2.42 at 12 m.

## Distribution of Benthic Taxa

The spatial-temporal distributions of the dominant three Oligochaetes and four Chironomids are shown in Tables 3.3.4-6 to -12.

### OLIGOCHAETES

#### *Nais pardalis*

*Nais pardalis* was most abundant during October (Table 3.3.4-6). At this time highest concentrations were noted at 1 m along the Douglas Point, Bruce GS 'B' discharge and intake transects. Higher concentrations at 3 m and 7 m were noted along the Douglas Point transect.

#### *Nais* spp

*Nais* spp represents immature Oligochaetes which could not be speciated. The occurrence of these organisms at the 1 m and 3 m depths was widespread during June (Table 3.3.4-7). At this time highest abundances were noted along the Douglas Point transect at 1 m and 3 m depths. During October these immature Oligochaetes were collected only at the 1 and 12 m depths along the Douglas Point transect and at the 12 m depth along the Gunn Point transect.

#### Tubificidae

Most Tubificidae were collected during October (Table 3.3.4-8). At this time, the occurrence of Tubificidae was widespread. Greatest concentrations were noted at the 7 m and 12 m depths along the Douglas Point, Bruce GS 'B' discharge, South Boundary and Gunn Point transects. Tubificidae were present in samples at each depth along the Douglas Point and Bruce GS 'B' discharge.

## Table 3.3.4-5

### SPATIAL-TEMPORAL DISTRIBUTION OF ZOOBENTHIC DIVERSITY INDICES BRUCE GS 'B' - 1979

| June | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point | |
|---|---|---|---|---|---|---|---|---|
| 1 m | 1.90 | 1.49 | 0.0 | 1.92 | 1.95 | 2.92 | 2.16 | 1.76 |
| 3 m | 1.69 | 2.06 | 1.79 | 2.11 | 0.92 | 1.83 | 2.24 | 1.81 |
| 7 m | 1.92 | 2.00 | 0.0 | 1.59 | 0.0 | 0.0 | 2.00 | 1.07 |
| 12 m | 1.59 | 2.25 | 0.92 | 1.91 | 2.75 | 3.24 | 0.0 | 1.81 |
| $\bar{x}$ | 1.78 | 1.95 | 0.68 | 1.88 | 1.41 | 2.00 | 1.60 | $\bar{x}$=1.61 |

| Oct | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point | |
|---|---|---|---|---|---|---|---|---|
| 1 m | 1.20 | 1.33 | 1.04 | 1.10 | 1.13 | 3.20 | 1.81 | 1.54 |
| 3 m | 1.13 | 1.34 | 2.58 | 1.29 | 1.69 | 2.11 | 2.26 | 1.77 |
| 7 m | 1.55 | 1.00 | 2.97 | 2.76 | 2.51 | 1.59 | 2.63 | 2.14 |
| 12 m | 3.07 | 1.59 | 2.28 | 3.14 | 2.92 | 1.50 | 2.42 | 2.42 |
| $\bar{x}$ | 1.74 | 1.32 | 2.22 | 2.07 | 2.06 | 2.10 | 2.28 | $\bar{x}$=1.97 |

## Table 3.3.4-6

### SPATIAL-TEMPORAL DISTRIBUTION OF *NAIS PARDALIS* COLLECTED. VALUES REPRESENT PER CENT OF THE TOTAL *NAIS PARDALIS* COLLECTED BRUCE GS 'B' - 1979

June 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | - | 2 | - | <1 | <1 | <1 | <1 |
| 3 Meters | <1 | <1 | - | - | - | - | - |
| 7 Meters | - | - | - | - | - | - | <1 |
| 12 Meters | - | - | - | - | <1 | <1 | - |

October 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | 16 | 4 | 15 | 14 | 4 | <1 | <1 |
| 3 Meters | 8 | 3 | 1 | 4 | 6 | 1 | - |
| 7 Meters | 9 | - | <1 | 1 | <1 | - | <1 |
| 12 Meters | 2 | - | <1 | 1 | 1 | - | <1 |

# Table 3.3.4-7

## SPATIAL-TEMPORAL DISTRIBUTION OF *NAIS SPP* COLLECTED. VALUES REPRESENT PER CENT OF THE TOTAL *NAIS SPP* FOUND - BRUCE GS 'B' - 1979

| June 1979 | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | 11 | 5 | - | 2 | 7 | 4 | 4 |
| 3 Meters | 11 | 4 | 5 | 5 | - | 9 | 4 |
| 7 Meters | - | - | - | - | - | - | - |
| 12 Meters | - | - | - | 4 | 4 | 4 | - |

| Oct 1979 | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | 9 | - | - | - | - | - | - |
| 3 Meters | - | - | - | - | - | - | - |
| 7 Meters | - | - | - | - | - | - | - |
| 12 Meters | 5 | - | - | - | - | - | 2 |

## Table 3.3.4-8

## SPATIAL-TEMPORAL DISTRIBUTION OF TUBIFICIDAE COLLECTED. VALUES REPRESENT PER CENT OF THE TOTAL TUBIFICIDS COLLECTED BRUCE GS 'B' - 1979

June 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | - | - | - | <1 | - | - | - |
| 3 Meters | - | - | - | - | - | - | - |
| 7 Meters | - | - | - | - | - | - | - |
| 12 Meters | - | - | - | - | - | - | - |

Oct 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | <1 | 2 | 9 | - | - | - | - |
| 3 Meters | 5 | - | 3 | <1 | 2 | - | - |
| 7 Meters | 16 | - | 9 | 3 | 4 | - | 13 |
| 12 Meters | 5 | - | 5 | 2 | 11 | 2 | 6 |

### CHIRONOMIDAE

#### Orthocladiinae

Orthocladiinae larvae were abundant in October samples (Table 3.3.4-9). At this time, larvae were most abundant in samples from Bruce GS 'B' discharge, Bruce GS 'B' intake and South Boundary. Along these transects peak abundances were noted at 7 m.

#### Theinemannimyia Group

Theinemannimyia group abundances were greatest during October (Table 3.3.4-10). Occurrences at this time were widespread. Peak abundances were observed along the Bruce GS 'B' discharge and Bruce GS 'B' intake transects at 7 m.

#### *Pseudosmittia* spp

*Pseudosmittia* spp occurred only in samples taken during October (Table 3.3.4-11). Peak abundances were found in 3 m samples from Bruce GS 'B' intake, South Boundary and Holmes Bay transects. Larvae were present at all depths only along the Douglas Point transect.

#### *Micropsectra (Paratanytarsus)* spp

*Micropsectra* occurred only in October samples (Table 3.3.4-12). Larvae were only present in samples south from the Bruce GS 'B' discharge. Peak concentrations were noted along the Holmes Bay and Gunn Point transects at 3 m and at the 7 m depth along the Bruce GS 'B' intake.

Mutual Information Analysis and Discriminant Function Analysis was not presented on these data. The overwhelming dominance of the Oligochaete *Nais pardalis* meant assemblages formed were primarily subgroups of *Nais* spp dominance. These subgroups overlapped showing little separation when plotted against the environmental parameters - substrate size, per cent algal cover, water temperature, dissolved oxygen and secchi disc.

### 3.3.5 Fish Community

Traditionally environmental impacts and effects are measured by comparing fish densities and abundances under preoperational and postoperational conditions. This section characterizes the larval, juvenile and adult fish communities under preoperational conditions in the vicinity of Bruce GS 'B'.

The surface-pelagic and benthy-pelagic larval fish community in the vicinity of Bruce GS 'B' was sampled by larval tows. A total of 1500 larval fish was collected from May through August

# Table 3.3.4-9

SPATIAL-TEMPORAL DISTRIBUTION OF ORTHOCLADIINAE COLLECTED.
VALUES REPRESENT PER CENT OF THE TOTAL ORTHOCLADIINAE FOUND
BRUCE GS 'B' - 1979

June 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | - | - | - | - | <1 | <1 | <1 |
| 3 Meters | - | - | - | - | <1 | - | - |
| 7 Meters | - | <1 | - | - | <1 | - | <1 |
| 12 Meters | <1 | - | 1 | - | <1 | <1 | - |

Oct 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | 3 | <1 | 1 | 8 | <1 | <1 | <1 |
| 3 Meters | 1 | - | <1 | 2 | 10 | <1 | - |
| 7 Meters | - | - | 12 | 14 | 13 | - | - |
| 12 Meters | 4 | - | 4 | 4 | 11 | - | - |

## Table 3.3.4-10

### SPATIAL-TEMPORAL DISTRIBUTION OF *THIENEMANNIMYIA* GROUP COLLECTED. VALUES REPRESENT PER CENT OF THE TOTAL *THIENEMANNIMYIA* FOUND IN JUNE AND OCTOBER - BRUCE GS 'B' - 1979

June 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | - | 2 | - | - | - | - | - |
| 3 Meters | 2 | 2 | - | - | - | 2 | 3 |
| 7 Meters | - | - | - | - | - | - | - |
| 12 Meters | - | 2 | - | 2 | 2 | 2 | - |

Oct 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | 5 | - | 3 | 6 | 2 | 5 | - |
| 3 Meters | - | - | 2 | - | 2 | 2 | 2 |
| 7 Meters | 5 | 2 | 22 | 18 | - | - | 2 |
| 12 Meters | 3 | - | 2 | - | 3 | 2 | - |

## Table 3.3.4-11

### SPATIAL DISTRIBUTION OF *PSEUDOSMITTIA SPP* COLLECTED IN OCTOBER VALUES REPRESENT PER CENT OF THE TOTAL *PSEUDOSMITTIA SPP* FOUND BRUCE GS 'B' - 1979

Oct 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | 4 | 6 | 6 | 19 | 11 | 11 | - |
| 3 Meters | 6 | - | - | 2 | 2 | 4 | 2 |
| 7 Meters | 4 | - | 4 | 4 | 2 | - | 9 |
| 12 Meters | 2 | - | - | - | - | - | - |

## Table 3.3.4-12

### SPATIAL DISTRIBUTION OF *MICROPSECTRA (PARATANYTARSUS) SPP* COLLECTED IN OCTOBER. VALUES REPRESENT PER CENT OF THE TOTAL *MICROPSECTRA (PARATANYTARSUS) SPP* FOUND BRUCE GS 'B' - 1979

Oct 1979

| | Douglas Point | Lagoon Bay | Bruce 'B' Discharge | Bruce 'B' Intake | South Boundary | Holmes Bay | Gunn Point |
|---|---|---|---|---|---|---|---|
| 1 Meter | - | - | - | 4 | - | 4 | 11 |
| 3 Meters | - | - | - | - | - | 18 | 25 |
| 7 Meters | - | - | 4 | 18 | 4 | 4 | 7 |
| 12 Meters | - | - | - | 4 | - | - | - |

(Table 3.3.5-1). The larval fish community was dominated by alewife (56%, 90.0 fish/1000 $m^3$) and smelt (37%, 59.9 fish/1000 $m^3$), with very limited number of burbot (2%, 3.1 fish/1000 $m^3$), Johnny Darter (1%, 2.3 fish/1000 $m^3$) and yellow perch (1%, 1.7 fish/1000 $m^3$) making up most of the remainder (Appendix M).

The adjust juvenile fish community in the vicinity of Bruce GS 'B' was sampled using gill nets, trap nets and beach seines. A total of 13,952 adult and juvenile fish representing 34 species was collected from May through November 1979 (Table 3.3.5-2) Appendices N, O and P. The dominant fish species were alewife (63%), longnose sucker (8%), lake chub (6%), white sucker (6%), spottail shiner (5%), gizzard shad (5%), yellow perch (4%) and round whitefish (1%).

The onshore (3 m contour) and offshore (12 m contour) benthypelagic fish community in the vicinity of Bruce GS 'B' was sampled by gill nets. A total of 8603 fish representing 25 species was collected from May through November 1979 (Table 3.3.5-3). Alewife (55%, 34.0 fish/set) was the dominant species caught, followed in decreasing order by longnose sucker (11%, 6.5 fish/set), lake chub (9%, 5.4 fish/set), gizzard shad (8%, 5.0 fish/set), white sucker (8%, 4.9 fish/set), yellow perch (6%, 3.4 fish/set) and round whitefish (2%, 1.4 fish/set).

The onshore benthic fish community in the vicinity of Bruce GS 'B' was sampled by 1.2 m trap nets. From May through November 1979, a total of 518 fish in 12 species was collected. Longnose sucker (32%, 2.9 fish/set), white sucker (27%, 2.5 fish/set), lake chub (17%, 1.6 fish/set), alewife (15%, 1.4 fish/set) and yellow perch (5%, 0.5 fish/set) were the dominant species collected (Table 3.3.5-4).

The nearshore fish community in the vicinity of Bruce GS 'B' was sampled by beach seines. A total of 4831 fish comprising 15 species was collected in the nearshore waters from May through November 1979 (Table 3.3.5-5). Alewife was the dominant fish species comprising 81% of the total catch with an estimated density of 70.7 fish/1000 $m^3$). Various minnow species, including spottail shiner (14%, 12.4 fish/1000 $m^3$), emerald shiner (1%, 1.2 fish/1000 $m^3$), longnose dace (1%, 0.9 fish/1000 $m^3$) and common shiner (1%, 0.8 fish/1000 $m^3$) comprised most of the remaining catch.

## Spatial Distribution and Habitat Associations

Fish are not distributed uniformly within the range where they occur, but are found more commonly in their optimal habitat and with decreasing frequency with increasing distance from this habitat. If the presence of Bruce GS 'B' affects the optimality of the habitat then this should be evident from shifts in species abundance. This section describes the spatial-habitat distribution of fish species prior to initiation of Bruce GS 'B' operations.

## Table 3.3.5-1

### RELATIVE FREQUENCY OF OCCURRENCE OF VARIOUS SPECIES IN LARVAL TOWS BRUCE GS 'B' - 1979

| Species | Per Cent | Number Captured | Samples Present* | Estimated Density (per $10^3 m^3$) |
|---|---|---|---|---|
| Alewife | 56.0 | 840 | 40 | 90.0 |
| Rainbow Smelt | 37.3 | 559 | 53 | 59.9 |
| Burbot | 1.9 | 29 | 18 | 3.1 |
| Johnny Darter | 1.4 | 21 | 12 | 2.3 |
| Yellow Perch | 1.1 | 16 | 10 | 1.7 |
| Slimy Sculpin | 0.5 | 8 | 2 | 0.9 |
| Deepwater Sculpin | 0.5 | 7 | 6 | 0.8 |
| Minnow Species | 0.5 | 7 | 7 | 0.8 |
| Perch Species | 0.4 | 6 | 5 | 0.6 |
| Whitefish Species | 0.3 | 5 | 5 | 0.5 |
| Trout-Perch | 0.1 | 2 | 1 | 0.2 |

*Total Samples = 280

## Table 3.3.5-2

## PERCENT COMPOSITION OF TOTAL FISH CATCH ALL GEAR TYPES BRUCE GS 'B', MAY - NOVEMBER 1979

| Species | Total Number | Percent Composition |
|---|---|---|
| Alewife | 8731 | 62.6 |
| Longnose Sucker | 1072 | 7.7 |
| Lake Chub | 859 | 6.2 |
| White Sucker | 825 | 5.9 |
| Spottail Shiner | 692 | 5.0 |
| Gizzard Shad | 691 | 5.0 |
| Yellow Perch | 498 | 3.6 |
| Round Whitefish | 196 | 1.4 |
| Emerald Shiner | 66 | 0.5 |
| Burbot | 50 | 0.4 |
| Smelt | 50 | 0.4 |
| Longnose Dace | 49 | 0.4 |
| Common Shiner | 46 | 0.3 |
| Redhorse Sucker | 23 | 0.2 |
| Walleye | 19 | 0.1 |
| Smallmouth Bass | 13 | 0.1 |
| Rainbow Trout | 12 | 0.1 |
| Bluntnose Minnow | 10 | 0.1 |
| White Bass | 8 | 0.1 |
| Carp | 6 | 0.0 |
| Coho Salmon | 5 | 0.0 |
| Freshwater Drum | 4 | 0.0 |
| Stone Cat | 4 | 0.0 |
| Cisco | 3 | 0.0 |
| Channel Catfish | 3 | 0.0 |
| Chinook Salmon | 3 | 0.0 |
| Ninespine Stickleback | 3 | 0.0 |
| Slimy Sculpin | 3 | 0.0 |
| Brown Trout | 2 | 0.0 |
| Splake | 2 | 0.0 |
| Log Perch | 1 | 0.0 |
| Northern Pike | 1 | 0.0 |
| Pumpkinseed | 1 | 0.0 |
| Rock Bass | 1 | 0.0 |

## Table 3.3.5-3

## RELATIVE FREQUENCY OF OCCURRENCE OF VARIOUS SPECIES COLLECTED BY GILL NETS IN THE VICINITY OF BRUCE GS 'B' - 1979

| Species | Percent | Total | # Samples | Catch Per 24 h Set |
|---|---|---|---|---|
| Alewife | 54.9 | 4723 | 71 | 34.0 |
| Longnose Sucker | 10.5 | 907 | 119 | 6.5 |
| Lake Chub | 8.8 | 755 | 103 | 5.4 |
| Gizzard Shad | 8.0 | 689 | 21 | 5.0 |
| White Sucker | 7.9 | 679 | 110 | 4.9 |
| Yellow Perch | 5.5 | 470 | 82 | 3.4 |
| Round Whitefish | 2.2 | 193 | 72 | 1.4 |
| Burbot | 0.6 | 50 | 30 | 0.4 |
| Smelt | 0.5 | 44 | 26 | 0.3 |
| Walleye | 0.2 | 19 | 13 | 0.1 |
| Redhorse Sucker | 0.2 | 17 | 13 | 0.1 |
| Rainbow Trout | 0.1 | 12 | 9 | 0.1 |
| White Bass | 0.1 | 8 | 6 | 0.1 |
| Smallmouth Bass | 0.1 | 7 | 3 | 0.1 |
| Carp | 0.1 | 6 | 6 | 0.0 |
| Coho Salmon | 0.1 | 5 | 5 | 0.0 |
| Freshwater Drum | 0.1 | 4 | 4 | 0.0 |
| Channel Catfish | 0.0 | 3 | 3 | 0.0 |
| Cisco | 0.0 | 3 | 2 | 0.0 |
| Stone Cat | 0.0 | 2 | 2 | 0.0 |
| Splake | 0.0 | 2 | 2 | 0.0 |
| Brown Trout | 0.0 | 2 | 1 | 0.0 |
| Slimy Sculpin | 0.0 | 1 | 1 | 0.0 |
| Chinook Salmon | 0.0 | 1 | 1 | 0.0 |
| Northern Pike | 0.0 | 1 | 1 | 0.0 |
|  | 100.0 | 8603 |  |  |

*Total Samples = 139

## Table 3.3.5-4

## RELATIVE FREQUENCY OF OCCURRENCE OF VARIOUS SPECIES COLLECTED BY TRAP NETS IN THE VICINITY OF BRUCE GS 'B' - 1979

| Species | Percent | Total | # Samples | Catch per 24 h Set |
|---|---|---|---|---|
| Longnose Sucker | 31.7 | 164 | 16 | 2.9 |
| White Sucker | 26.8 | 139 | 15 | 2.5 |
| Lake Chub | 17.4 | 90 | 9 | 1.6 |
| Alewife | 14.9 | 77 | 3 | 1.4 |
| Yellow Perch | 5.4 | 28 | 8 | 0.5 |
| Redhorse Sucker | 1.2 | 6 | 5 | 0.1 |
| Smallmouth Bass | 1.2 | 6 | 3 | 0.1 |
| Round Whitefish | 0.6 | 3 | 2 | 0.1 |
| Stone Cat | 0.4 | 2 | 1 | 0.0 |
| Smelt | 0.2 | 1 | 1 | 0.0 |
| Rock Bass | 0.2 | 1 | 1 | 0.0 |
| Pumpkinseed | 0.2 | 1 | 1 | 0.0 |
| | 100.0 | 518 | | |

Total Samples = 56

## Table 3.3.5-5

## RELATIVE FREQUENCY OF OCCURRENCE OF VARIOUS SPECIES COLLECTED BY BEACH SEINES IN THE VICINITY OF BRUCE GS 'B' - 1979

| Species | Percent | Total | # Samples | Estimated Density number/100 $m^3$ |
|---|---|---|---|---|
| Alewife | 81.4 | 3931 | 18 | 70.2 |
| Spottail Shiner | 14.3 | 692 | 26 | 12.4 |
| Emerald Shiner | 1.4 | 66 | 18 | 1.2 |
| Longnose Dace | 1.0 | 49 | 24 | 0.9 |
| Common Shiner | 1.0 | 46 | 2 | 0.8 |
| Lake Chub | 0.3 | 14 | 10 | 0.3 |
| Bluntnose Minnow | 0.2 | 10 | 14 | 0.2 |
| White Sucker | 0.1 | 7 | 6 | 0.1 |
| Smelt | 0.1 | 5 | 6 | 0.1 |
| Ninespine Stickleback | 0.1 | 3 | 6 | 0.1 |
| Slimy Sculpin | 0.0 | 2 | 4 | 0.0 |
| Gizzard Shad | 0.0 | 2 | 2 | 0.0 |
| Chinook Salmon | 0.0 | 2 | 2 | 0.0 |
| Log Perch | 0.0 | 1 | 2 | 0.0 |
| Longnose Sucker | 0.0 | 1 | 2 | 0.0 |
|  | 100.0 | 4831 |  |  |

Total Samples = 56

Densities of larval alewife, smelt and burbot were high enough to allow statistical comparisons within the Bruce GS 'B' sampling area (Table 3.3.5-6). Larval alewife in surface waters were concentrated in Lagoon Bay (ANOVA, $P < 0.001$), with a calculated density of 240 fish/1000 $m^3$ of lake water. The lowest alewife density was observed at South Boundary (49 fish/1000 $m^3$), while densities at other locations ranged from 67 fish/1000 $m^3$) at Gunn Point to 87 fish/1000 $m^3$ at Bruce GS 'B' discharge. Surface densities of larval smelt ranged from 26 fish/1000 $m^3$ at Holmes Bay to 88 fish/1000 $m^3$ at Bruce GS 'B' discharge. Over the entire sampling period, smelt larvae were not as abundant as alewife larvae. Burbot larvae were not recorded at South Boundary during the season and occurred in comparatively smaller surface densities than smelt or alewife, ranging from 3 fish/1000 $m^3$) at Bruce GS 'B' intake to 5 fish/1000 $m^3$ at Gunn Point. Generally, the larvae of other fish species caught in the vicinity of Bruce GS 'B' were in quite low abundance (Table 3.3.5-6). Unidentifiable whitefish larvae (<2fish/1000 $m^3$) were only captured in the Holmes Bay and Gunn Point areas.

Table 3.3.5-7 gives larval densities observed at each sampling contour for surface and bottom tows. In surface tows, little variation in larval fish density existed between depth contours. However, for smelt and alewife larvae, densities along the lake bottom at the 7 m depth were significantly higher than those at the 12 m depth (ANOVA, $P < 0.001$). Apart from burbot larvae at the 12 m depth (4 fish/1000 $m^3$) and yellow perch and slimy sculpin larvae at the 7 m depth (4 fish/1000 $m^3$), larvae of other fish species were observed in very low abundance in bottom tows.

The densities of the juvenile and adult fish captured in gill nets differed substantially with onshore-offshore and alongshore sample locations (Table 3.3.5-8). In onshore (3 m) gill nets fish were captured most frequently in Holmes Bay (111.9 fish/24 h), followed by Gunn Point (90.5 fish/24 h), Bruce GS 'B' discharge (88.2 fish/24 h), Bruce GS 'B' intake (73.8 fish/24 h) and Douglas Point (32.2 fish/24 h). In offshore (12 m) gill nets fish were captured most frequently at Bruce GS 'B' discharge (58.8 fish/24 h), followed by Gunn Point (42.6 fish/24 h), Douglas Point (42.0 fish/24 h), Bruce GS 'B' intake (39.4 fish/24 h) and Holmes Bay (34.0 fish/24 h). Capture frequency was highest for trap nets (Table 3.3.5-9) set in Bruce GS 'B' discharge (14.4 fish/24 h) and Gunn Point (14.2 fish/24 h), followed by Holmes Bay (5.71 fish/24 h) and Douglas Point (2.36 fish/24 h). Capture frequency for beach seines (Table 3.3.5-10) was highest in Holmes Bay (273.3 fish/100 $m^3$), followed by Gunn Point (39.7 fish/100 $m^3$), Bruce GS 'B' discharge (28.8 fish/100 $m^3$) and Douglas Point (1.0 fish/100 $m^3$).

In all two-way (location by month) and three-way (location by month by depth) analyses (ANOVA) of the three most frequently captured juvenile and adult fish in the various gear types, there were significant first order and second order location and/or depth effects. The only exception was the gill net data for alewife in which only first-order depth effects were significant.

## Table 3.3.5-6

### LARVAL FISH ABUNDANCE (FISH/1000 $m^3$) AT VARIOUS SAMPLING LOCATIONS IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

| | Lagoon Bay | Bruce GS 'B' Discharge | Bruce GS 'B' Intake | South Boundary | Holme's Bay | Gunn Point |
|---|---|---|---|---|---|---|
| Alewife | 240.4 | 86.8 | 68.3 | 49.1 | 80.4 | 66.8 |
| Rainbow Smelt | 69.0 | 87.5 | 49.1 | 70.4 | 25.6 | 74.0 |
| Burbot | 3.6 | 4.3 | 2.8 | 0.0 | 3.6 | 5.0 |
| Johnny Darter | 1.4 | 1.4 | 2.1 | 5.6 | 2.1 | 2.1 |
| Yellow Perch | 0.0 | 2.8 | 4.3 | 0.7 | 0.0 | 2.1 |
| Slimy Sculpin | 0.0 | 0.0 | 4.3 | 0.0 | 0.0 | 0.0 |
| Deepwater Sculpin | 0.0 | 1.4 | 0.7 | 0.0 | 0.7 | 0.7 |
| Minnow Species | 1.4 | 1.4 | 2.1 | 0.0 | 0.0 | 0.0 |
| Perch Species | 0.7 | 0.0 | 0.0 | 1.4 | 2.1 | 0.0 |
| Whitefish Species | 0.0 | 0.0 | 0.7 | 0.0 | 1.4 | 1.4 |
| Trout-Perch | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 |

## Table 3.3.5-7

### LARVAL FISH ABUNDANCE (FISH/1000 $m^3$) IN SURFACE AND BOTTOM TOWS TAKEN AT 3, 7 AND 12 m CONTOURS IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

| | Surface Tows | | | Bottom Tows | |
|---|---|---|---|---|---|
| | 3 m Contour | 7 m Contour | 12 m Contour | 7 m Contour | 12 m Contour |
| Alewife | 104.5 | 107.4 | 83.9 | 12.8 | 4.3 |
| Rainbow Smelt | 76.8 | 71.8 | 39.1 | 64.0 | 2.1 |
| Burbot | 4.6 | 2.5 | 2.5 | 0.0 | 4.3 |
| Johnny Darter | 5.3 | 1.4 | 0.7 | 0.0 | 0.0 |
| Yellow Perch | 0.7 | 2.8 | 1.4 | 4.3 | 0.0 |
| Slimy Sculpin | 0.0 | 0.0 | 2.1 | 4.3 | 0.0 |
| Deepwater Sculpin | 0.7 | 0.4 | 0.7 | 2.1 | 2.1 |
| Minnow Species | 2.1 | 0.0 | 0.4 | 0.0 | 0.0 |
| Perch Species | 1.1 | 0.7 | 0.4 | 0.0 | 0.0 |
| Whitefish Species | 0.4 | 0.7 | 0.7 | 0.0 | 0.0 |
| Trout-Perch | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 |

## Table 3.3.5-8

## JUVENILE AND ADULT FISH ABUNDANCE (FISH/24-H SET) MEASURED BY GILL NETS AT VARIOUS SAMPLING LOCATIONS IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

| | Douglas Point | | Bruce 'B' Discharge | | Bruce 'B' Intake | | Holmes Bay | | Gunn Point | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 m | 12 m | 3 m | 12 m | 3 m | 12 m | 3 m | 12 m | 3 m | 12 m |
| Alewife | 14.5 | 23.1 | 56.5 | 35.4 | 39.1 | 25.4 | 60.8 | 15.2 | 44.1 | 23.1 |
| Longnose Sucker | 3.9 | 7.1 | 5.6 | 9.6 | 8.0 | 3.8 | 7.9 | 3.3 | 10.1 | 5.6 |
| Lake Chub | 1.9 | 2.7 | 6.5 | 5.0 | 3.6 | 3.8 | 9.5 | 5.2 | 10.3 | 5.5 |
| Gizzard Shad | 4.6 | 0.0 | 12.1 | 0.4 | 11.0 | 1.1 | 12.4 | 0.9 | 6.7 | 0.0 |
| White Sucker | 2.9 | 2.4 | 2.8 | 3.8 | 6.4 | 1.3 | 11.1 | 3.6 | 10.4 | 3.7 |
| Yellow Perch | 1.9 | 2.6 | 1.4 | 2.7 | 2.1 | 1.8 | 8.1 | 4.5 | 5.5 | 3.0 |
| Round Whitefish | 1.4 | 2.3 | 1.9 | 1.4 | 2.2 | 0.5 | 1.0 | 0.6 | 1.7 | 0.9 |
| Burbot | 0.0 | 1.0 | 0.0 | 0.9 | 0.0 | 0.7 | 0.1 | 0.3 | 0.1 | 0.4 |
| Rainbow Smelt | 0.8 | 0.4 | 0.4 | 0.1 | 0.0 | 0.6 | 0.0 | 0.1 | 0.6 | 0.1 |
| Walleye | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.0 | 0.1 | 0.0 |
| Redhorse Sucker | 0.3 | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 0.4 | 0.0 |
| Rainbow Trout | 0.3 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 0.1 | 0.0 |
| White Bass | 0.1 | 0.0 | 0.1 | 0.0 | 0.4 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Smallmouth Bass | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 |
| Carp | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 |
| Coho Salmon | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 |
| Freshwater Drum | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Channel Catfish | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Cisco | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 |
| Stone Cat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| Splake | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Brown Trout | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Slimy Sculpin | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Chinook Salmon | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Northern Pike | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |

## Table 3.3.5-9

## JUVENILE AND ADULT FISH ABUNDANCE (FISH/24-H SET) MEASURED BY 1.2-m TRAP NETS AT VARIOUS SAMPLING LOCATIONS IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

| | Douglas Point | Bruce GS 'B' Discharge | Holmes Bay | Gunn Point |
|---|---|---|---|---|
| Longnose Sucker | 1.0 | 5.5 | 0.3 | 4.9 |
| White Sucker | 0.8 | 5.5 | 1.6 | 2.1 |
| Lake Chub | 0.2 | 2.6 | 0.2 | 3.4 |
| Alewife | 0.3 | 0.0 | 2.7 | 2.5 |
| Yellow Perch | 0.0 | 0.5 | 0.4 | 1.2 |
| Redhorse Sucker | 0.0 | 0.2 | 0.1 | 0.1 |
| Smallmouth Bass | 0.3 | 0.0 | 0.1 | 0.0 |
| Round Whitefish | 0.0 | 0.1 | 0.1 | 0.0 |
| Stone Cat | 0.0 | 0.0 | 0.1 | 0.0 |
| Rainbow Smelt | 0.0 | 0.0 | 0.1 | 0.0 |
| Rock Bass | 0.0 | 0.0 | 0.0 | 0.1 |
| Pumpkinseed | 0.1 | 0.0 | 0.0 | 0.0 |

## Table 3.3.5-10

## JUVENILE AND ADULT FISH ABUNDANCE (FISH/100 $m^3$) MEASURED BY BEACH SEINE AT VARIOUS SAMPLING LOCATIONS IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

| | Douglas Point | Bruce GS 'B' Discharge | Holmes Bay | Gunn Point |
|---|---|---|---|---|
| Alewife | 0.0 | 1.0 | 265.6 | 14.2 |
| Spottail Shiner | 0.4 | 26.0 | 2.6 | 20.4 |
| Emerald Shiner | 0.0 | 0.4 | 0.4 | 3.9 |
| Longnose Dace | 0.1 | 0.3 | 0.4 | 0.5 |
| Common Shiner | 0.0 | 0.0 | 3.3 | 0.0 |
| Lake Chub | 0.4 | 0.4 | 0.1 | 0.2 |
| Bluntnose Minnow | 0.1 | 0.0 | 0.3 | 0.4 |
| White Sucker | 0.0 | 0.1 | 0.3 | 0.1 |
| Rainbow Smelt | 0.0 | 0.1 | 0.1 | 0.1 |
| Ninespine Stickleback | 0.0 | 0.1 | 0.1 | 0.1 |
| Slimy Sculpin | 0.0 | 0.1 | 0.0 | 0.1 |
| Gizzard Shad | 0.0 | 0.1 | 0.0 | 0.0 |
| Chinook Salmon | 0.0 | 0.1 | 0.0 | 0.0 |
| Log Perch | 0.0 | 0.0 | 0.1 | 0.0 |
| Longnose Sucker | 0.0 | 0.0 | 0.1 | 0.0 |

Nearly twice as many fish were captured in onshore gill nets than offshore gill nets (Table 3.3.5-8). At all sample sites, gizzard shad and redhorse suckers were captured more frequently in onshore gill nets than offshore gill nets and burbot were captured more frequently in offshore gill nets than onshore gill nets (sign test, $P = 0.032$).

More detailed analyses indicated that depth not only had significant first-order effects in the three most frequently captured species in gill nets, but that there were also significant interactions between depth and sample location, and depth and month (see section on Temporal Variation and Migratory Patterns) in longnose sucker and lake chub (Figure 3.3.5-1). Longnose sucker were captured twice as frequently in offshore versus onshore gill nets set in the northern sampling locations of Douglas Point and the Bruce GS 'B' discharge and were captured twice as frequently in the onshore versus offshore gill nets set at the Bruce GS 'B' intake, Gunn Point and Holmes Bay. Lake chub were captured about equally in onshore and offshore gill nets set at Douglas Point, Bruce GS 'B' intake and Bruce GS 'B' discharge locations, but were captured more than twice as frequently in onshore nets in the more southern sampling locations of Gunn Point and Holmes Bay.

In all gear types (Figure 3.3.5-1, -2), alewife captures were highest in Holmes Bay. Longnose sucker were captured most frequently in offshore gill nets set at Bruce GS 'B' discharge and were captured most frequently in onshore gill nets and trap nets set at Gunn Point. Similarly, longnose sucker were captured most frequently in trap nets set at Bruce GS 'B' discharge and Gunn Point (Table 3.3.5-9). Trap net catches of white sucker and yellow perch were highest at Bruce GS 'B' discharge and Gunn Point, respectively (Table 3.3.5-9). Beach seine catches of spottail shiner were highest at Bruce GS 'B' intake, emerald shiner at Gunn Point and common shiner at Holmes Bay (Table 3.3.5-10).

While there was substantial variation among sample sites in the catch per unit effort data for juvenile and adult fish, this variation did not appear to be due to habitat associations. In none of the most frequently captured species did densities appear to be related to algae cover or substrate type.

### Fish Diversity and Community Structure

While there is evidence that diversity is directly correlated with stability, it is not certain whether the relationship is a result of a cause or an effect (Odum, 1971). Some workers feel that species diversity is partly a product of a stable environment (Margalef, 1963; Connel and Orians, 1964; Dunbar, 1968; Sanders, 1968), while others feel that diversity may contribute to ecosystem stability by increasing the number and complexity of biological interactions (MacArthur 1955, Hutchinson 1959). In

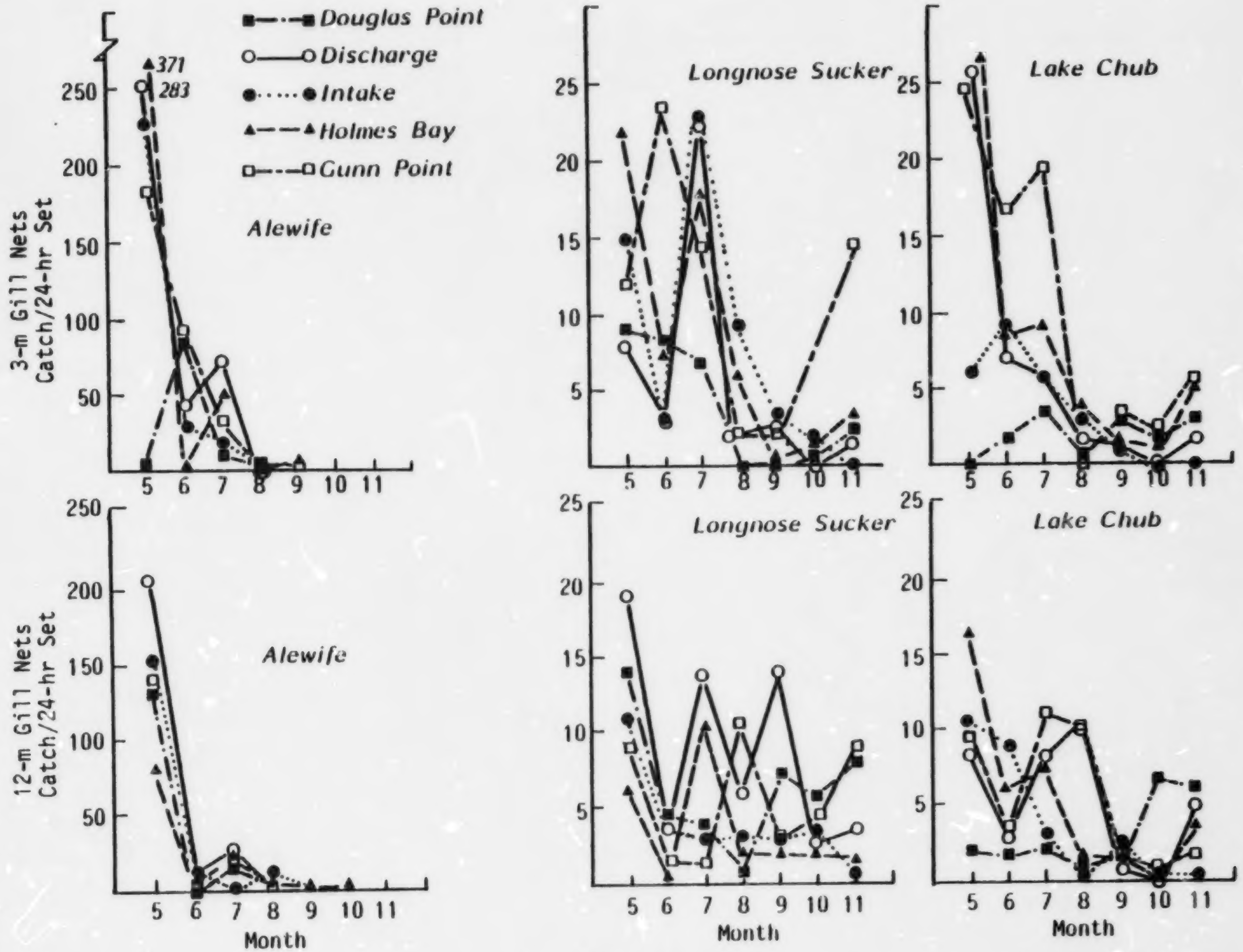


FIGURE 3.3.5-1

SEASONAL, DEPTH AND SITE RELATIONSHIPS OF FISH ABUNDANCE MEASURED FROM GILL NET DATA COLLECTED IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

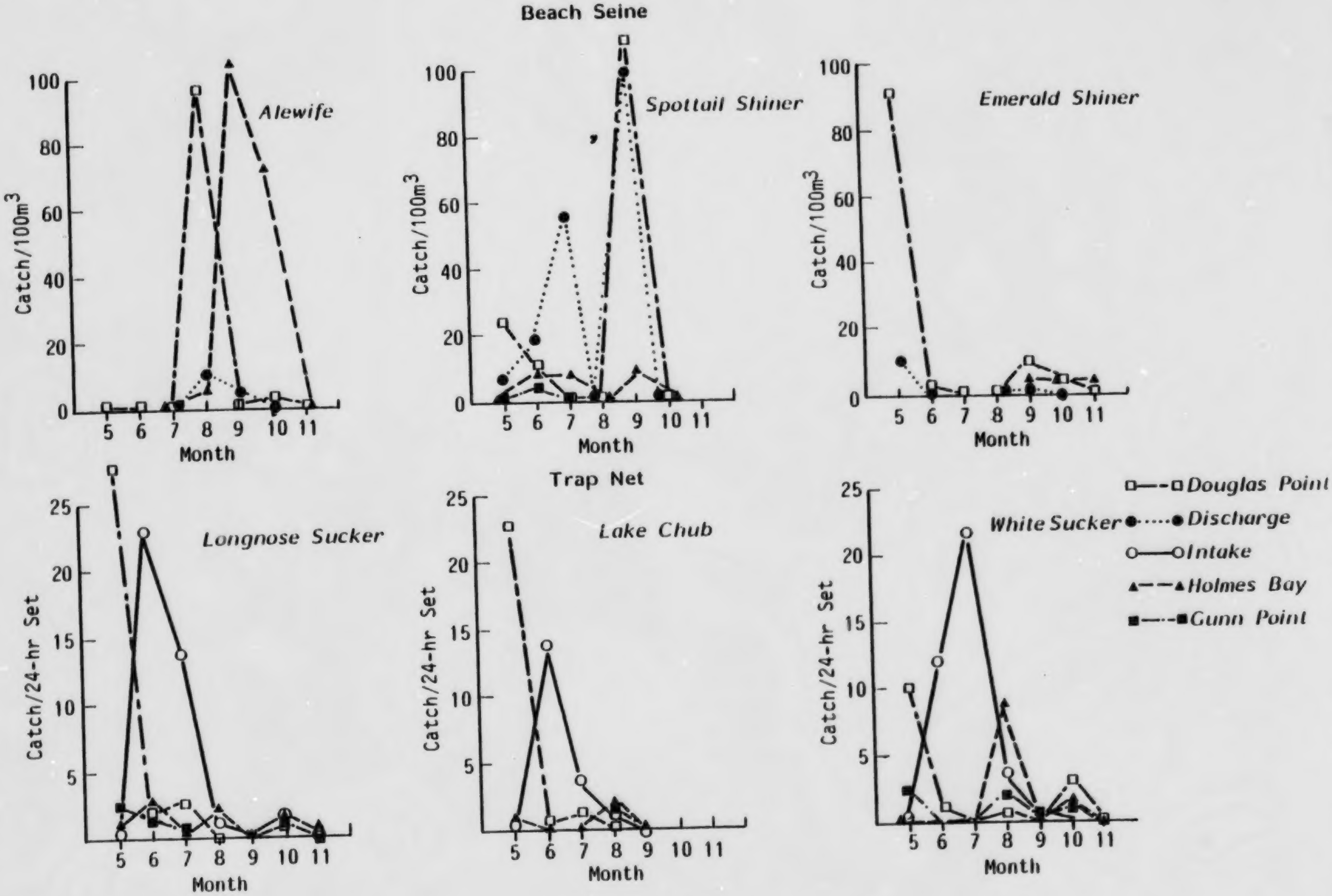


FIGURE 3. 3. 5-2

SEASONAL AND SITE RELATIONSHIPS OF FISH ABUNDANCE MEASURED FROM BEACH SEINE AND TRAP NET DATA COLLECTED IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979 any case, physically harsh environments or seriously polluted environments are characterized by low diversity, while diversity is higher in unstressed, or stable environments (Odum 1971). Thus a reduction in species diversity coinciding with the operation of Bruce GS 'B' may be an indication of stress and instability.

The number of species present is one measure of the diversity of the fish community. In total, 37 fish species were captured in the vicintiy of Bruce GS 'B' in 1979. The number of species present did not differ greatly among alongshore sampling locations.

Fifteen species were captured by gill nets in all onshore sampling locations except Gunn Point (16), and 11 species were captured at all offshore sampling locations except Douglas Point and Holmes Bay (12) (Table 3.3.5-8). The number of species captured in trap nets was highest at Holmes Bay (10) followed in decreasing order by Gunn Point (7), Douglas Point (6) and Bruce GS 'B' discharge (6) (Table 3.3.5-9). The number of species captured in beach seines was also highest at Holmes Bay (12) followed in decreasing order by Bruce GS 'B' intake (11), Gunn Point (10) and Douglas Point (4) (Table 3.3.5-10).

However, the number of species present was significantly higher in onshore gill net samples than offshore samples (sign test, P = 0.031). This was not the case for surface larval tows (Table 3.3.5-6), although the number of species present seemed to decrease with depth. At the 7 m contour there were 8 species present in surface tows and 5 present in bottom tows, and at the 12 m contour there were 10 species present in surface tows and 4 species present in bottom tows (Table 3.3.5-7).

Another indication of community diversity is the evenness of the proportional representation of the various species. Overall, alewife dominated the fish community in the vicinity of Bruce GS 'B', being greater than 8 times more abundant than the next most abundant species. The proportional representation of the dominant species (alewife) was generally more than three times greater than the next most abundant species taken in gill net samples in the vicinity of Bruce GS 'B'. The beach seine catch from Holmes Bay was also totally dominated by alewife (96% of catch), while spottail shiner dominated the beach seine catch from Bruce GS 'B' intake (90% of catch, Table 3.3.5-10). Dominant species were less than 50% greater than the next most abundant species in beach seine catches from Douglas Point and Gunn Point and trap net catches from all locations (Table 3.3.5-9).

Low fish diversity may thus be the result of few species being present or the dominance of the community by one or two species. Fish community diversity is often measured by a diversity index of these two components. While diversity indices measured from beach seine (Figure 3.3.5-3, ANOVA, P = 0.06) and trap net data (Figure 3.3.5-3, ANOVA, P = 0.0004) varied significantly with season, there was not significant first-order variation among

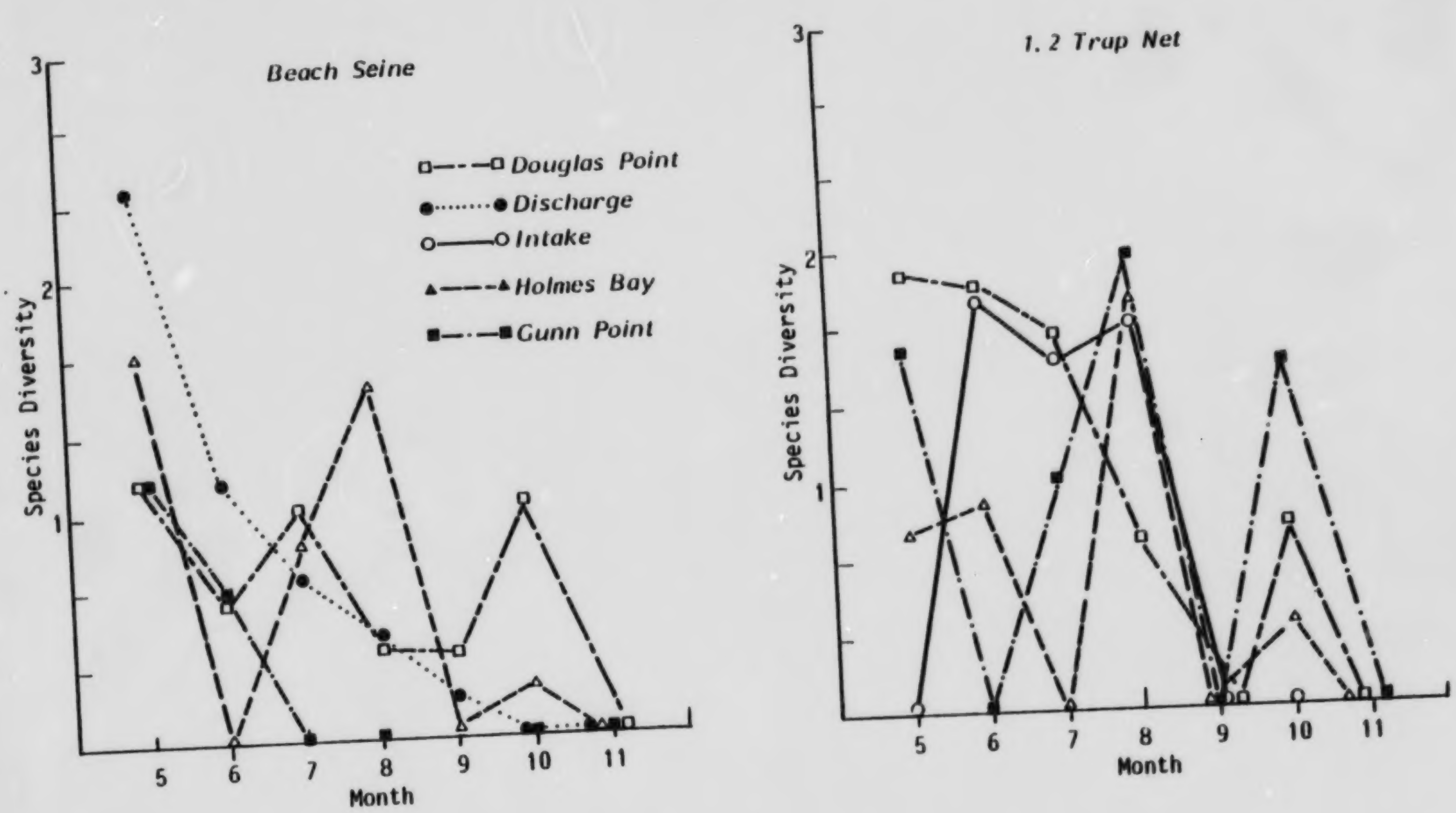


FIGURE 3.3.5-3

SPATIAL-TEMPORAL VARIATION IN FISH DIVERSITY
(SHANNON-WIENER INDEX) MEASURED WITH BEACH SEINE AND TRAP NET DATA
BRUCE GS 'B' 1979

sample locations. However, there was a significant interaction between location and season for trap net data (P = 0.004), indicating that from May through July there was significant variation in fish diversity measured at the various sampling locations (Figure 3.3.5-3). Fish diversity measured from gill net data varied substantially with season and depth, as seen in Figure 3.3.5-4.

## Population Structure

Changes in population structure near power plants on the Great Lakes have been observed and attributed to the enhancement of degradation to the aquatic environment by station operations (see Lawler, Matusky and Skelly 1979 for a review). Further, normal plant operations usually involve some size selective predation (eg, impingement, Foster 1979). Thus, examinations of fish population structure were carried out in order to characterize population structure of selected species under the preoperational conditions existing in the vicinity of Bruce GS 'B'.

In 1979 the age and length structure of populations of four species were examined: walleye, yellow perch, white sucker and longnose sucker (Figures 3.3.5-5, -6). Population structure data were collected from fish captured in gill nets and trap nets.

The limited population structure data for walleye are somewhat ambiguous. The age structure of walleye seems to indicate a negative exponential expected of the population as a whole (Ricker 1975). However, more older fish would be expected in the sample. If larger numbers of older fish do not occur in future samples, then the aquatic habitat in the vicinity of Bruce GS 'B' would appear to be populated primarily by walleye just reaching maturity (2-4 yrs, >279 mm for males and 3-6 yrs, 356-432 mm for males, Scott and Crossman 1973).

In the vicinity of Bruce GS 'B' populations of yellow perch, white sucker and longnose sucker were primarily made up of larger and older fish. However, when larger fish of a given species are found to be more numerous in a particular habitat, then it is not apparent whether the optimal habitat for these fish are different from smaller fish, or that there is one overall optimal habitat for all size classes, and the larger sizes are able to exclude the smaller size classes by some behavioural mechanism. In any case, under preoperational conditions, the population structure of yellow perch, white sucker and longnose sucker was dominated by adults, with sub-adult fish being virtually absent.

## Temporal Relationships and Migratory Patterns

Concerns have been raised that intake and/or discharge flows may block migratory routes of adult as well as larval fish (MacLaren 1969). Further, fish attraction to a thermal effluent and other

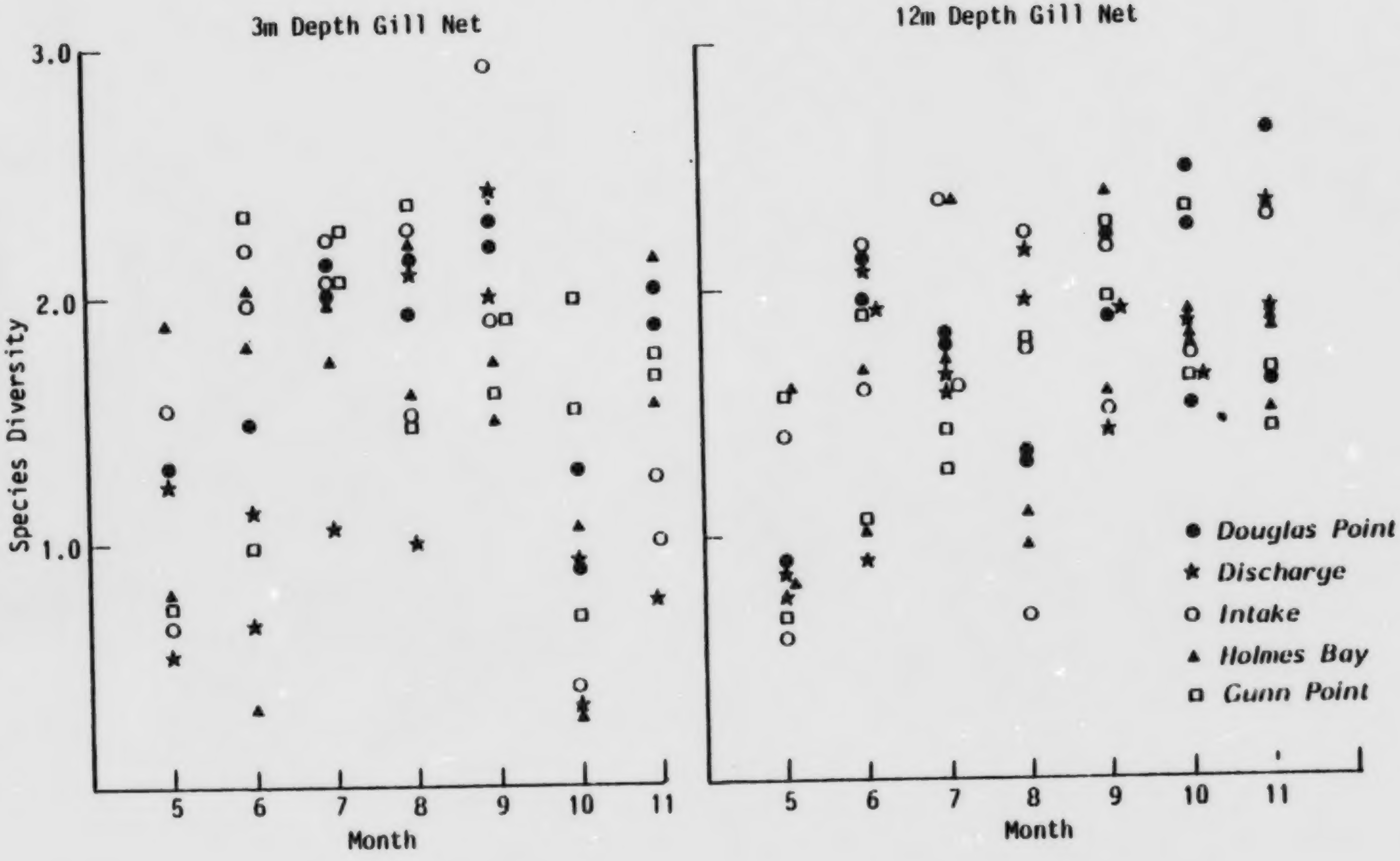


FIGURE 3.3.5-4

SPATIAL-TEMPORAL VARIATION IN FISH DIVERSITY
(SHANNON-WEINER INDEX) MEASURED WITH GILL NET DATA
BRUCE GS 'B' 1979

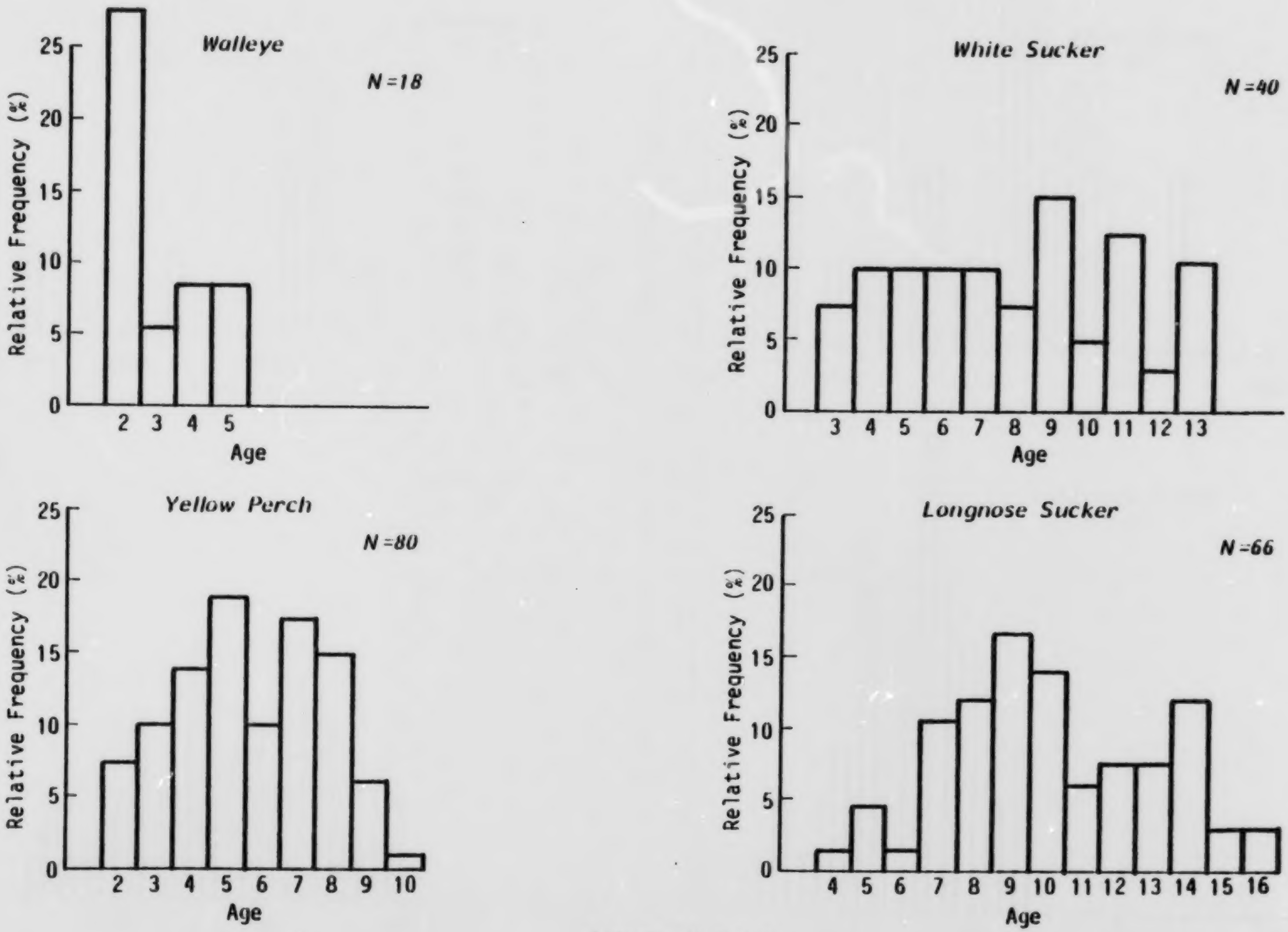


FIGURE 3.3.5-5

AGE-FREQUENCY DISTRIBUTION FOR WALLEYE, YELLOW PERCH, WHITE SUCKER AND LONGNOSE SUCKER CAPTURED IN THE VICINITY OF BRUCE GS 'B' IN 1979

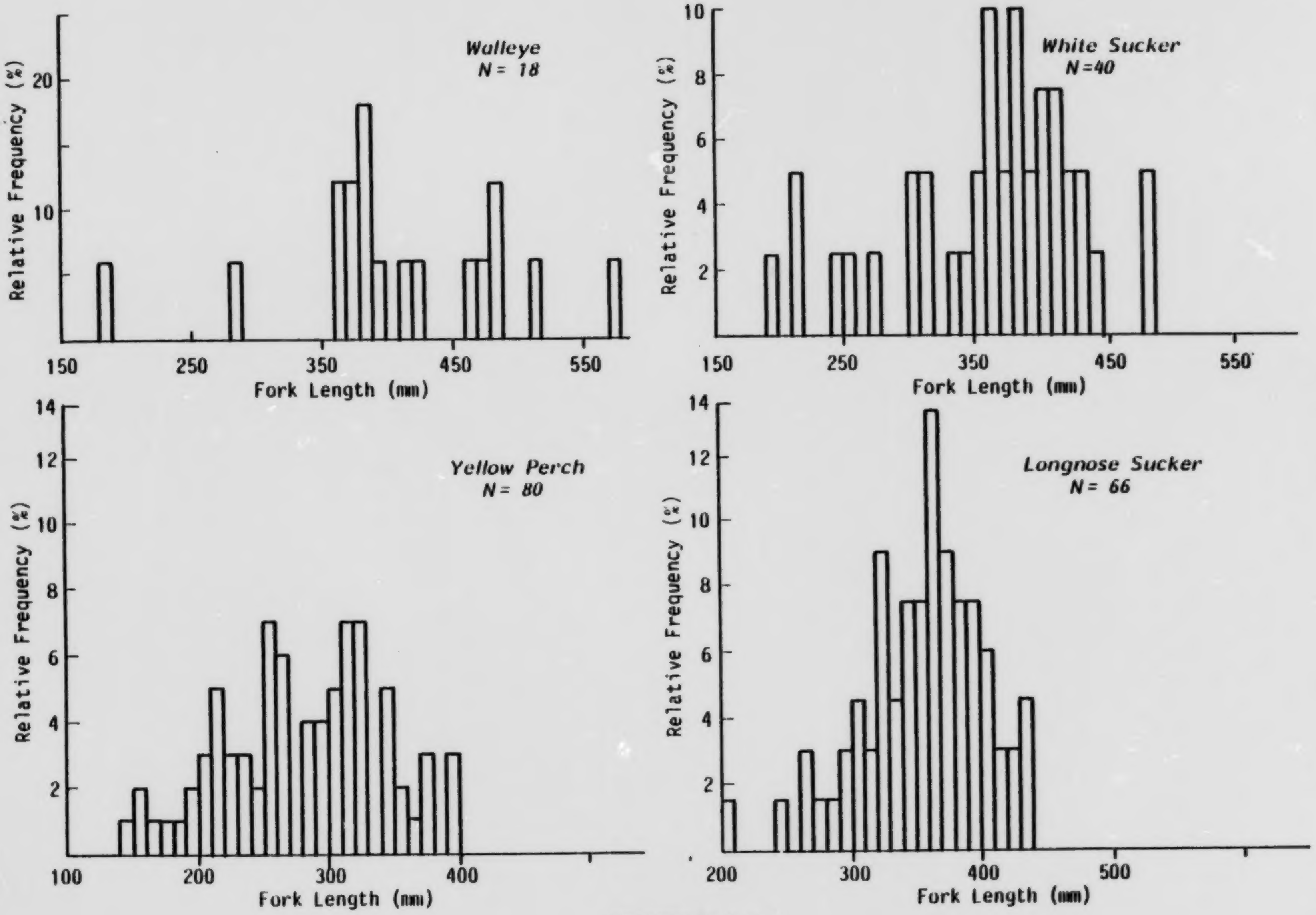


FIGURE 3.3.5-6

LENGTH-FREQUENCY DISTRIBUTION FOR WALLEYE, YELLOW PERCH, WHITE SUCKER, AND LONGNOSE SUCKER CAPTURED IN THE VICINITY OF BRUCE GS 'B' IN 1979 features of a power plant may interfere with normal migratory patterns with adverse results (Romberg et al 1974, Spigarelli 1975). Thus, power plants may artificially prolong residency in the vicinity of the power plant so that fish do not reach its preferred spawning, nursery or feeding grounds at the biologically appropriate time.

In examining fish migrations, it is not only necessary to know that a fish was present at a given location, but it is also necessary to know where it had been previously and where it would be at subsequent times. Thus, conventional fisheries' methodologies of netting employed in this study are not well suited to answering questions involving fish migratory patterns. However, gross movements of fish can be examined through the analysis of the temporal sequence of catch per unit effort data. This is due to the fact that virtually no species of fish are year-round residents in the exposed nearshore waters of the Great Lakes (Scott and Crossman 1973). Thus, temporal variation in catch per unit effort is primarily the result of migratory onshore-offshore and alongshore movements. This section will provide some baseline information on fish migratory patterns in the vicinity of Bruce GS 'B' as reflected by temporal variation in catch per unit effort data.

These data are summarized by gear types in Tables 3.3.5-11 to 3.3.5-14 and by total catch in Figures 3.3.5-7, -8.

Gill net data suggest that alewife moved into and out of the sampling locations at relatively the same time and in relatively the same magnitudes (Figure 3.3.5-1). While alewife abundance was nearly twice as high in the onshore gill net locations as the offshore locations (ANOVA, $P = 0.032$), and decreased progressively from May through the sampling season (ANOVA, $P = <0.0001$), there was no significant interaction between season and depth distribution, or season and sample location. However, in contrast to the gill net data, the beach seine data indicate two peaks in alewife abundance, with one occurring at Douglas Point in August and the other occurring in September-October at Holmes Bay (Figure 3.3.5-2).

Gill net data indicate that lake chub and longnose sucker densities were highest onshore from May through July. From August through October longnose sucker were more dense offshore than onshore, and in November they were evenly distributed. Lake chub were evenly distributed from August through November.

For most species the greatest differences in fish densities among sample sites were associated with spawning migrations and activities. For example, trap net data may indicate spawning movements near Douglas Point for longnose sucker, lake chub and white sucker and post-spawning movements into the intake area (Figure 3.3.5-2). For further discussion see the section on fish reproduction.

## Table 3.3.5-11

## SEASONAL DISTRIBUTION OF LARVAL FISH (NUMBER PER $10^3m^3$) IN THE VICINITY OF BRUCE GS 'B' FROM MAY - AUGUST 1979

|  | 16 May | 30 May | 13 June | 28 June | 10 July | 8 Aug | 20 Aug |
|---|---|---|---|---|---|---|---|
| Alewife | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 488.0 | 208.0 |
| Rainbow Smelt | 100.0 | 318.0 | 40.0 | 1.0 | 2.0 | 3.0 | 0.0 |
| Burbot | 9.7 | 11.2 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| Johnny Darter | 0.0 | 0.0 | 0.0 | 0.0 | 4.5 | 10.5 | 0.8 |
| Yellow Perch | 0.0 | 0.0 | 0.8 | 0.8 | 10.5 | 0.0 | 0.0 |
| Slimy Sculpin | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 | 0.0 | 0.0 |
| Deepwater Sculpin | 3.0 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Minnow Species | 0.0 | 0.0 | 0.8 | 0.0 | 3.8 | 1.5 | 0.0 |
| Perch Species | 0.0 | 0.0 | 0.8 | 0.0 | 0.8 | 3.0 | 0.0 |
| Whitefish Species | 0.0 | 0.0 | 1.5 | 2.3 | 0.0 | 0.0 | 0.0 |
| Trout-Perch | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 |

## Table 3.3.5-12

## SEASONAL DISTRIBUTION OF JUVENILE AND ADULT FISH (CUE) CAPTURED BY GILL NETS IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

| | May | June | July | Aug | Sept | Oct | Nov |
|---|---|---|---|---|---|---|---|
| Alewife | 178.4 | 28.4 | 26.1 | 2.8 | 0.5 | 0.1 | 0.1 |
| Longnose Sucker | 12.4 | 6.8 | 11.8 | 3.9 | 3.8 | 2.4 | 4.5 |
| Lake Chub | 14.5 | 6.4 | 7.5 | 3.1 | 1.8 | 1.3 | 3.2 |
| Gizzard Shad | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 33.6 | 0.7 |
| White Sucker | 6.1 | 3.3 | 4.9 | 3.7 | 8.6 | 3.8 | 3.7 |
| Yellow Perch | 1.2 | 6.3 | 8.0 | 5.3 | 1.9 | 1.0 | 0.0 |
| Round Whitefish | 1.7 | 0.9 | 0.2 | 0.3 | 1.9 | 2.1 | 2.7 |
| Burbot | 0.7 | 0.8 | 0.6 | 0.0 | 0.1 | 0.3 | 0.2 |
| Rainbow Smelt | 0.8 | 0.0 | 0.2 | 0.8 | 0.2 | 0.1 | 0.2 |
| Walleye | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 0.6 | 0.2 |
| Shorthead Redhorse | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 |
| Rainbow Trout | 0.3 | 0.0 | 0.1 | 0.0 | 0.1 | 0.2 | 0.1 |
| White Bass | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.2 | 0.0 |
| Smallmouth Bass | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.3 | 0.0 |
| Carp | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Coho Salmon | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 |
| Freshwater Drum | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 |
| Channel Catfish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| Cisco | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stone Cat | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 |
| Splake | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Brown Trout | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Slimy Sculpin | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Chinook Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Northern Pike | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |

## Table 3.3.5-13

## SEASONAL DISTRIBUTION OF JUVENILE AND ADULT FISH (CUE) CAPTURED BY TRAP NETS IN THE VICINITY OF BRUCE GS'B' FROM MAY - NOVEMBER 1979

| | May | June | July | Aug | Sept | Oct | Nov |
|---|---|---|---|---|---|---|---|
| Longnose Sucker | 8.1 | 6.8 | 5.0 | 0.8 | 0.0 | 0.8 | 0.0 |
| White Sucker | 3.4 | 3.3 | 5.5 | 3.8 | 0.1 | 1.4 | 0.0 |
| Lake Chub | 5.8 | 3.6 | 1.1 | 0.8 | 0.0 | 0.0 | 0.0 |
| Alewife | 9.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yellow Perch | 0.0 | 0.8 | 1.3 | 1.5 | 0.0 | 0.0 | 0.0 |
| Shorthead Redhorse | 0.0 | 0.3 | 0.3 | 0.1 | 0.0 | 0.1 | 0.0 |
| Smallmouth Bass | 0.0 | 0.0 | 0.1 | 0.6 | 0.0 | 0.0 | 0.0 |
| Round Whitefish | 0.1 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stone Cat | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 |
| Rainbow Smelt | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rock Bass | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Pumpkinseed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |

## Table 3.3.5-14

## SEASONAL DISTRIBUTION OF JUVENILE AND ADULT FISH (CUE) CAPTURED BY BEACH SEINE IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

| | May | June | July | Aug | Sept | Oct | Nov |
|---|---|---|---|---|---|---|---|
| Alewife | 0.1 | 0.0 | 0.0 | 26.0 | 446.8 | 18.5 | 0.0 |
| Spottail Shiner | 7.0 | 9.6 | 14.6 | 0.0 | 69.8 | 0.1 | 0.0 |
| Emerald Shiner | 6.4 | 0.1 | 0.0 | 0.0 | 0.6 | 0.5 | 3.5 |
| Longnose Dace | 1.1 | 2.1 | 2.0 | 0.6 | 0.3 | 0.0 | 0.0 |
| Common Shiner | 0.0 | 0.0 | 5.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lake Chub | 0.9 | 0.3 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bluntnose Minnow | 0.1 | 0.0 | 0.1 | 0.8 | 0.1 | 0.1 | 0.0 |
| White Sucker | 0.0 | 0.3 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rainbow Smelt | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ninespine Stickleback | 0.1 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Slimy Sculpin | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Gizzard Shad | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Chinook Salmon | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Log Perch | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Longnose Sucker | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

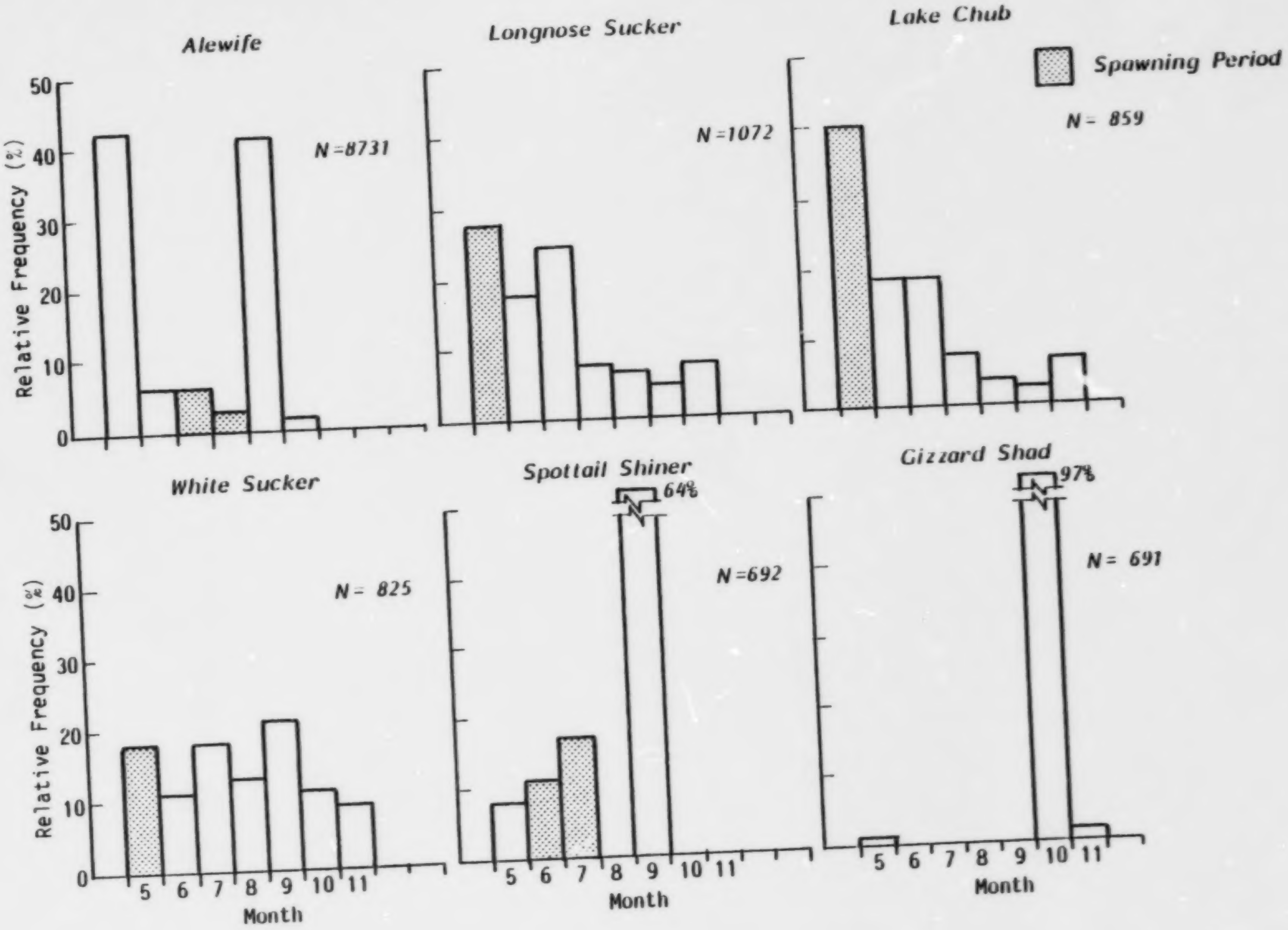


FIGURE 3.3.5-7

RELATIVE SEASONAL ABUNDANCE OF DOMINANT FISH SPECIES TAKEN IN ALL GEAR TYPES IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

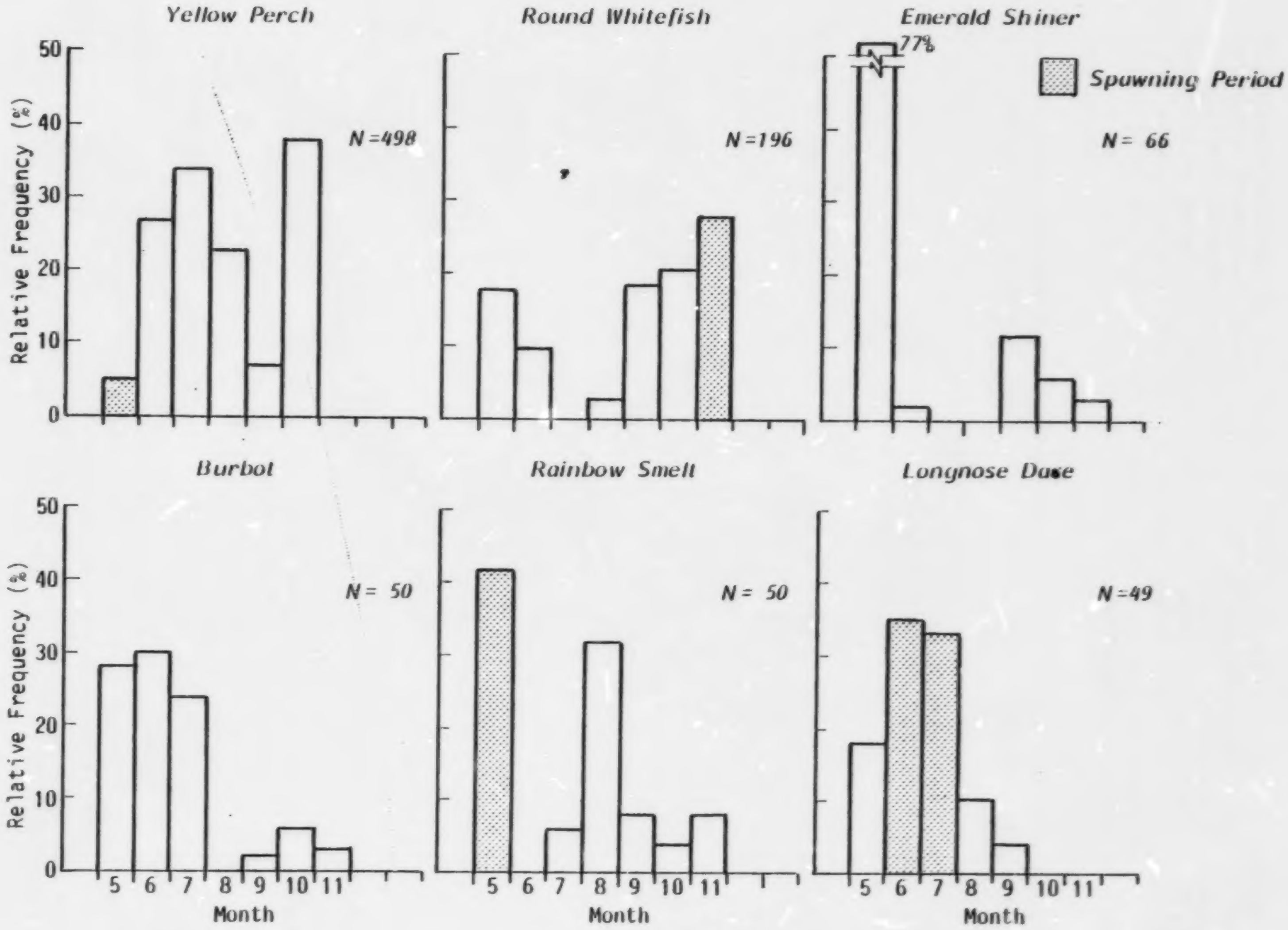


FIGURE 3.3.5-8

RELATIVE SEASONAL ABUNDANCE OF DOMINANT FISH SPECIES TAKEN IN ALL GEAR TYPES IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

Migratory movements for larval smelt and alewife were investigated by examining their onshore-offshore (Figure 3.3.5-9) and alongshore (Figure 3.3.5-10) distributional patterns during two successive sampling periods at their peak of abundance. While such spatial-temporal distributional patterns are likely to be associated with migratory movements, they may in fact be partially, or wholly, due to other factors such as differential predation.

Successive surface tows approximately two weeks apart suggest that both smelt and alewife move onshore at an early age (Figure 3.3.5-9). Smelt densities were highest at the 7 m contour on May 16 but by May 30 were highest onshore and decreased offshore from 3 m contour to the 12 m contour (chi square test, $P < 0.001$). Alewife densities were evenly distributed on August 8, but also decreased offshore on the next sampling period (chi square test $P < 0.001$).

The spatial distribution of larval alewife and rainbow smelt captured in surface tows also differed significantly in the north-south direction on successive sampling periods (chi square test, $P < 0.001$, Figure 3.3.5-10). On May 16 larval smelt were concentrated around the intake location, decreasing to the north-south, while by May 30 they had dispersed. On the other hand, larval alewife were concentrated at Lagoon Bay on August 8 and were concentrated at Holmes Bay on August 20. This may indicate a north to south movement pattern, associated with the direction of the prevailing currents (Ontario Hydro Research Division Report 80-291-K).

On a seasonal basis, two distinct peaks were observed for maximal larval smelt and alewife abundance (Figure 3.3.5-11). Whereas larval smelt predominated from mid-May to mid-June, with a peak density of $318/1000\ m^3$, alewife larvae were dominant from mid-July to mid-August with maximum density approaching $500/1000\ m^3$. These results reflect the sequential spring and summer spawning periods of adult smelt and alewife, as indicated in Figures 3.3.5-8 and 3.3.5-7, respectively.

Figure 3.3.5-12 illustrates the seasonal size distribution of larval smelt and alewife in the Bruce GS 'B' area. It is evident that at all sampling locations, larval smelt are relatively small (mean length approximately 6.0 mm) during their period of peak inshore abundance (May-June). The scarcity of larger-sized smelt larvae in inshore waters during the summer is probably related to movement to offshore locations as well as predation by other fish species. Alewife larvae were generally larger than smelt larvae during their peak abundance period (July-August). It is likely that the smaller alewife larvae were missed during the sampling program since no sampling was conducted between July 10 and August 8.

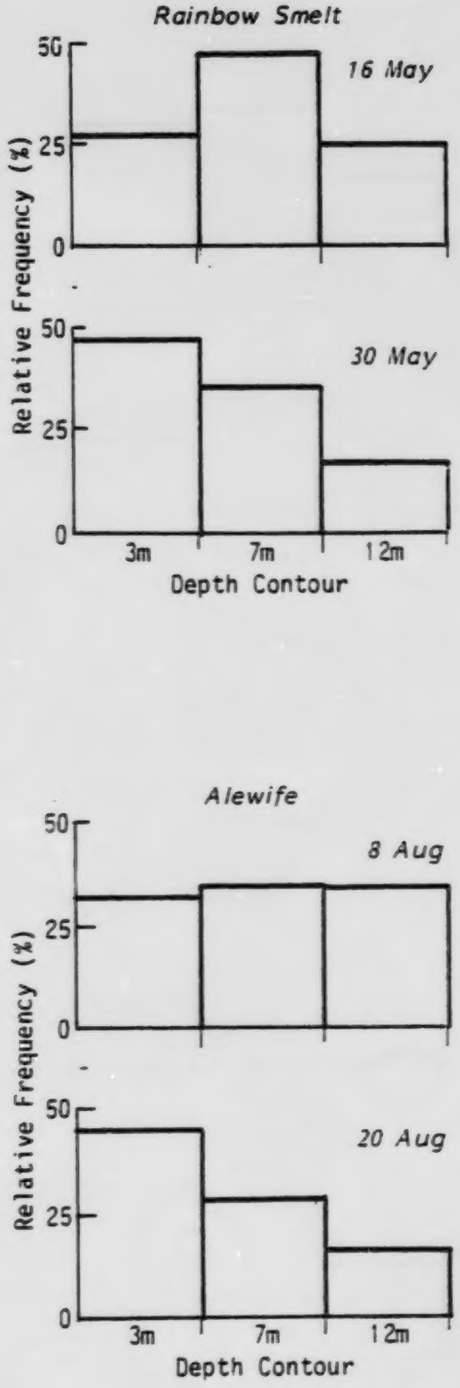


FIGURE 3.3.5-9

RELATIVE ONSHORE-OFFSHORE, SURFACE DISTRIBUTION OF LARVAL SMELT AND ALEWIFE ON TWO SUCCESSIVE SAMPLING PERIODS BRUCE GS 'B' 1979

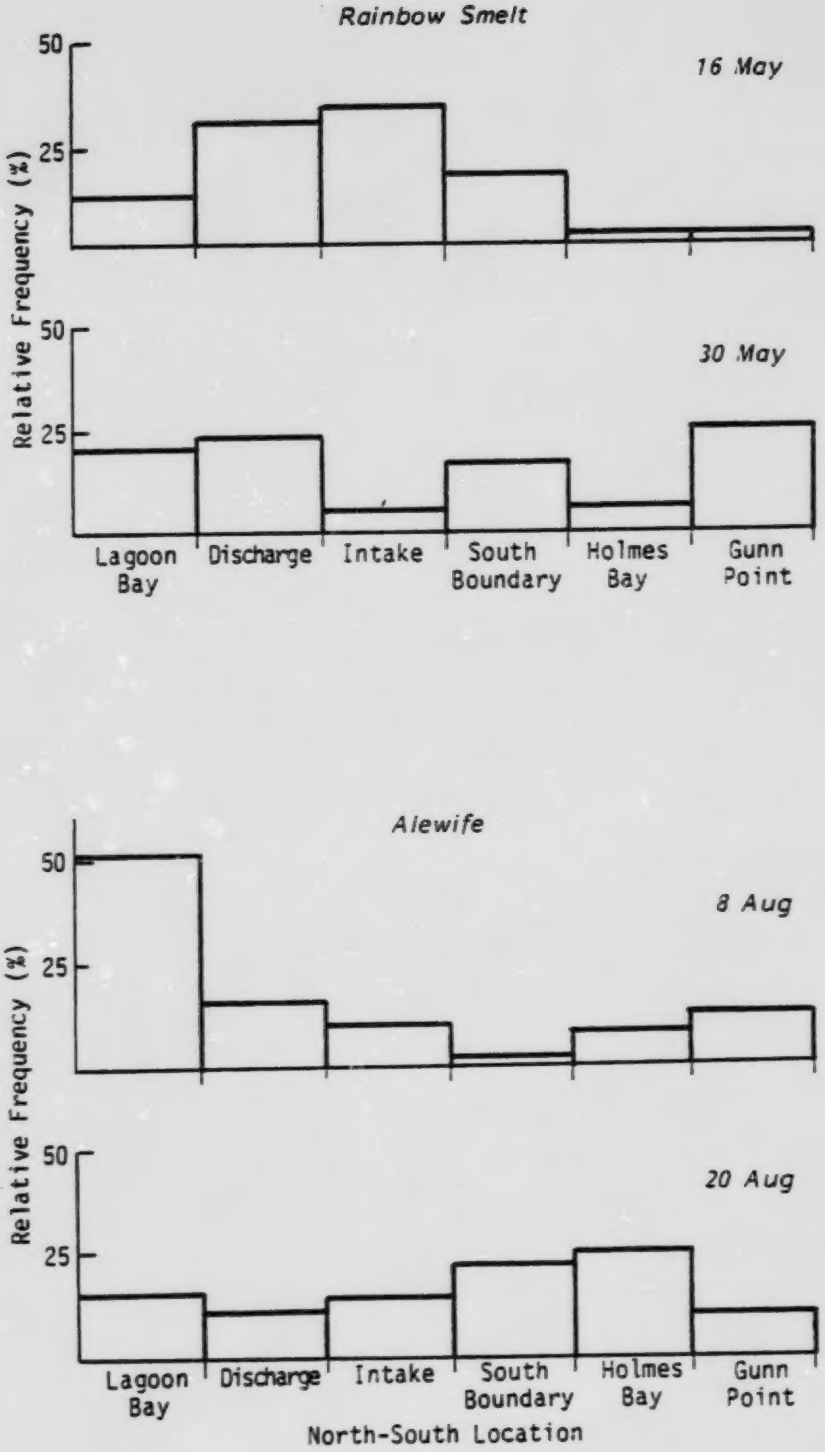


FIGURE 3.3.5-10

RELATIVE ALONGSHORE DISTRIBUTION OF LARVAL SMELT AND ALEWIFE ON TWO SUCCESSIVE SAMPLING PERIODS, BRUCE GS 'B' 1979

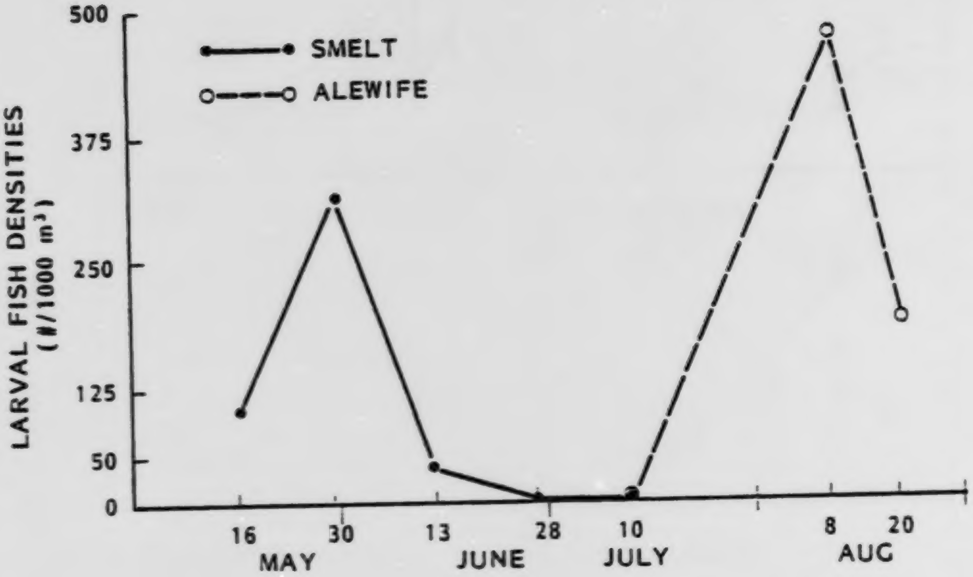


FIGURE 3.3.5-11

SEASONAL DENSITIES OF LARVAL SMELT AND ALEWIFE OBTAINED AT BRUCE GS 'B' - 1979

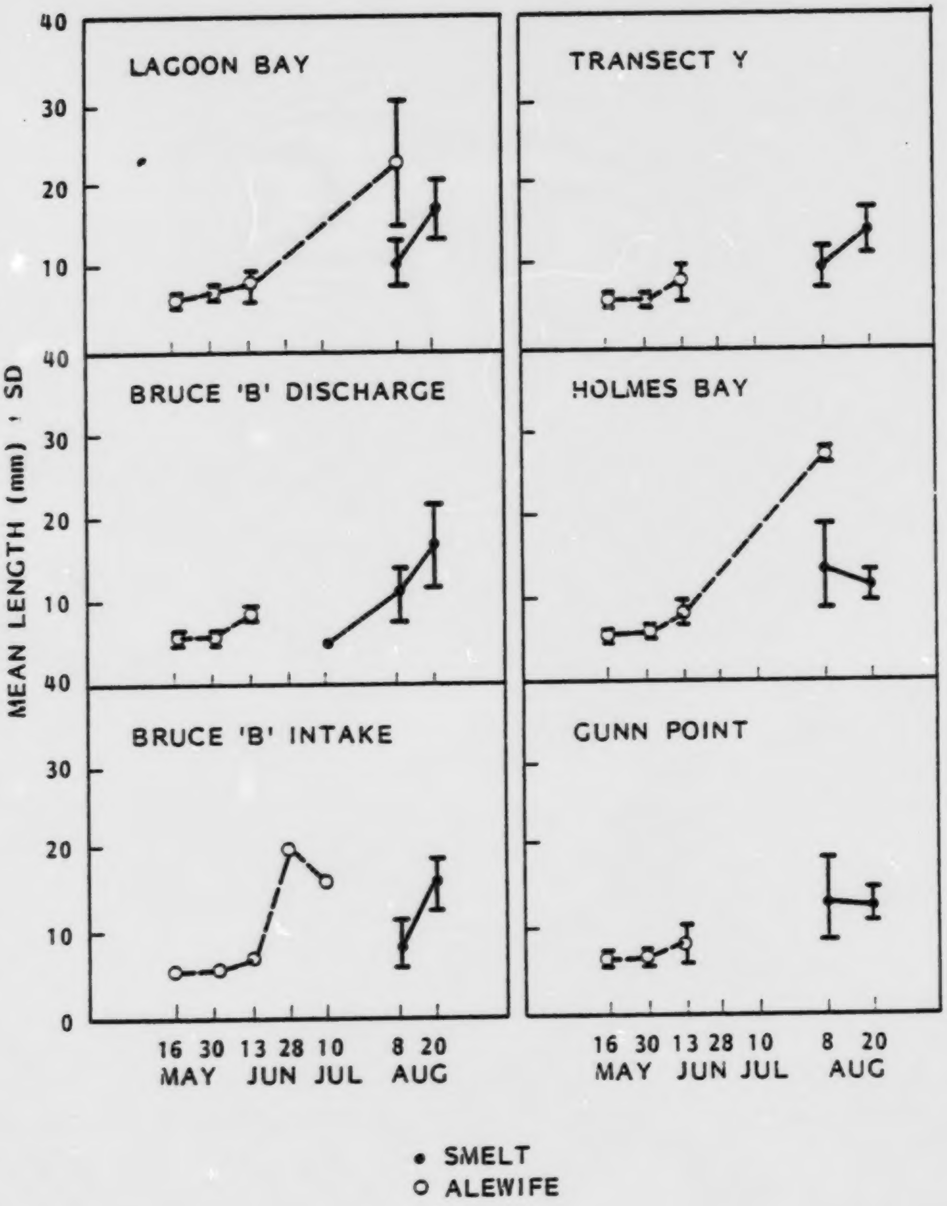


FIGURE 3.3.5-12

MEAN AND STANDARD DEVIATION OF LARVAL SMELT AND ALEWIFE CAUGHT BY SURFACE TOWS AT BRUCE GS 'B'-1979

## Reproduction

Shifts in spawning locations and the elimination or enhancement of spawning stocks have been attributed to the construction and operation of power stations (see Lawler, Matusky and Skelly 1979 for a review). For this reason baseline information was gathered to determine the significance of the aquatic habitat in the vicinity of Bruce GS 'B' as spawning and nursery grounds.

Spawning stocks vulnerable to Bruce GS 'B' effects are indicated by gill net, trap net and beach seine captures during spawning periods (Figures 3.3.5-7, -8). While the May through November field season missed the major spawning periods of some species such as rainbow smelt (April), lake chub (April), round whitefish (December) and burbot (January-March), the spawning periods of most species were sampled. Species in the vicinity of Bruce GS 'B' during their spawning periods include longnose sucker (May, 28% of total catch), lake chub (April-May, May, 40% of total catch), white sucker (May, 18% of total catch), spottail shiner (June-July, 28% of total catch), round whitefish (November-December, November 28% of total catch), rainbow smelt (April-May, May 42% of total catch), longnose dace (June-July, 67% of total catch), and common shiner (July, 100% of total catch). On the other hand, alewfie (July, 6% of total catch), gizzard shad (June, 0% of total catch), yellow perch (May, 5% of total catch) and emerald shiner (July, 0% of total catch) either leave the vicinity of Bruce GS 'B' to spawn, or occur in limited numbers at spawning times.

Larval fish catches may provide the best evidence of the extent to which the aquatic environment in the vicinity of the Bruce GS 'B' was used as spawning and nursery grounds (Table 3.3.5-1). For example, darters, deepwater sculpin, slimy sculpin and trout-perch larvae were present in the area, but adults were seldom captured in the sampling gear. Thus, the sampling methods utilized may not have been effective for determining the spawning populations of small benthic species.

Alewife and smelt predominated in the larval fish catches, with very limited numbers of larval burbot, Johnny darter and yellow perch making up most of the remainder (Table 3.3.5-1). However, there is little information available to determine whether larval fish were concentrated in the vicinity of Bruce GS 'B'. In Lake Huron rainbow smelt and alewife densities were generally higher in the vicinity of Bruce GS 'B' than in the vicinity of Bruce GS 'A' (Ontario Hydro Research Division Report 80-291-K). They were also higher in the vicinity of Bruce GS 'B' than on the north shore of Lake Erie near Nanticoke TGS (Telecki et al 1977), but were near the average densities found along the north shore of Lake Ontario (OHRDR 79-405-K and 80-69-K).

## Predator-Prey - Trophic Relationships

Changes in predator-prey and trophic relationships have been associated with operation of generating stations on the Great Lakes (Telecki et al 1977). Thus examinations of stomach contents were carried cut in order to characterize predator-prey and trophic relationships under preoperational conditions in the vicinity of Bruce GS 'B'. Such data will provide insights into whether organisms are preyed upon in essentially the same manner, by the same predators, and at the same time as in other portions of the lake or under postoperational conditions.

In 1979, the stomach contents of six species were examined: longnose sucker, white sucker, rainbow trout, white bass, yellow perch and walleye (Table 3.3.5-15). Stomach contents data were collected from fish captured in gill nets and trap nets.

The high proportion of fish in the stomach contents of yellow perch and white bass captured in the vicinity of Bruce GS 'B' may be a notable deviation from the usual diet of these species, although it may be partially due to biases introduced by the capture methodologies (regurgitation and the interaction between digestibility and latency to removal from nets, Foster 1977). While fish often make up a large proportion of the diet of yellow perch, aquatic invertebrates are usually of primary importance (Keast and Webb 1966, Telecki et al 1977). Similarly, the primary food of Oneida Lake white bass was aquatic insects (Forney and Taylor, 1953), while in the vicintiy of Bruce GS 'B' fish were the only prey found in white bass stomachs.

In general, the stomach contents of rainbow trout, walleye, longnose sucker and white sucker captured in the vicinity of Bruce GS 'B' did not seem to differ significantly from that reported in the literature (Scott and Crossman 1973). In the Great Lakes adult rainbow trout and walleye are generalists, piscivores that prey on a wide variety of fish. The limited data available indicate that both rainbow trout and walleye captured in the vicinity of Bruce GS 'B' fed exclusively on fish (Table 3.3.5-15). Similarly, suckers are generalists that feed on a wide variety of benthic invertebrates. In the vicinity of Bruce GS 'B', longnose sucker fed primarily on detritus, diptera and cladocerans and white sucker fed primarily on diptera, detritus, amphipods and gastropods.

## Growth

Operations of nuclear power stations on the Great Lakes have been shown to affect growth rates of fish (Ontario Hydro Research Division Report 78-198-K and 78-52-K). Thus length-age data of selected trap netted and gill netted fish were collected at Bruce GS 'B' in order to characterize the growth rates of fish under preoperational conditions. These growth rates will be later compared with those collected under postoperational

## Table 3.3.5-15

## PER CENT OCCURRENCE OF STOMACH CONTENTS FROM VARIOUS SPECIES CAPTURED IN THE VICINITY OF BRUCE GS 'B' - 1979

| | Longnose Sucker (N = 65) | White Sucker (N = 40) | Rainbow Trout (N = 4) | White Bass (N = 10) | Yellow Perch (N = 121) | Walleye (N = 10) |
|---|---|---|---|---|---|---|
| Invertebrates | | | | | | |
| Amphipoda | 4.6 | 22.5 | 0.0 | 0.0 | 0.9 | 0.0 |
| Hirudinea | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Decapoda | 0.0 | 5.0 | 0.0 | 0.0 | 26.4 | 0.0 |
| Isopoda | 1.5 | 10.0 | 0.0 | 0.0 | 0.9 | 0.0 |
| Coleoptera | 0.0 | 2.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Diptera | 20.0 | 32.5 | 0.0 | 0.0 | 0.9 | 0.0 |
| Ephemeroptera | 1.5 | 12.5 | 0.0 | 0.0 | 3.3 | 0.0 |
| Plecoptera | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 |
| Triohoptera | 3.0 | 7.5 | 0.0 | 0.0 | 0.9 | 0.0 |
| Gastropoda | 0.0 | 17.5 | 0.0 | 0.0 | 0.9 | 0.0 |
| Arachnida | 7.7 | 2.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cladocera | 10.8 | 12.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ostracoda | 4.6 | 7.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fish | | | | | | |
| Alewife | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 10.0 |
| Smelt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 30.0 |
| Sculpins | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 0.0 |
| Fish Eggs | 0.0 | 2.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fish Remains | 1.5 | 0.0 | 25.0 | 10.0 | 25.6 | 20.0 |
| Other | | | | | | |
| Detritus | 30.8 | 25.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Unidentifiable | 32.3 | 15.0 | 0.0 | 0.0 | 8.3 | 0.0 |
| Empty | 16.9 | 22.5 | 75.0 | 90.0 | 38.0 | 50.0 |

conditions in order to determine whether there were abrupt increases or decreases in growth coinciding with the commencement of station operations.

In the 1979 preoperational data set adequate sample sizes of age-length data were avilable for growth determinations of only four species: walleye (N = 11), yellow perch (N = 119), white sucker (N = 40) and longnose sucker (N = 66). Generally, growth rates of percids in the vicinity of Bruce GS 'B' can be characterized as being faster than that described in the literature. For example, growth of walleye in the vicinity of Bruce GS 'B' (Figure 3.3.5-13) was faster than at Lake Manitoba (Kennedy 1949), Lac la Ronge, Saskatchewan (Rawson 1957), and Bay of Quinte, Lake Ontario (Payne 1964). Similarly, growth of yellow perch in the vicinity of Bruce GS 'B' was faster than at Lake Erie, Ontario (Harkness 1922), Lake Jesse, Nova Scotia (Smith 1939), Hemming Lake, Manitoba (Lawler 1953) and Bay of Quinte, Lake Ontario (Sheri and Power 1969).

On the other hand, growth rate of the suckers can be characterized as being generally slower than that described in the literature. While growth of longnose sucker in the vicinity of Bruce GS 'B' was faster than at Pyramid Lake, Alberta (Rawson and Elsey 1950), it was slower than North Saskatchewan River, Saskatchewan (Reed 1962), and Great Slave Lake, Northwest Territories (Harris 1962). Similarly, growth of white sucker in the vicinity of Bruce GS 'B' was faster than at Gibson Lake, New Brunswick (Smith 1952) but slower than at Waskesiu Lake, Saskatchewan (Campbell 1935), Lake of the Woods (Chambers 1963) and George Lake, Ontario (Beamish 1970).

### 3.3.6 Acoustic Fish Census

Mean densities of fish echoes over the entire sample area ranged from 243/hectare during the day on June 6 to 512/hectare during the night on October 30 (Table 3.3.6-1). Difference in mean echo density among transects was not large and the direction of differences was inconsistent among sampling dates.

#### Distribution of Fish Echoes in Day Samples

The horizontal distribution of fish echoes in daytime sampling on June 6, August 20 and October 30 is shown in Figure 3.3.6-1. In each case a patchy distribution was observed with higher densities most commonly occurring near shore within the 15 m depth contour. In June, highest densities were apparent in the northern inshore corner of the sampling grid, while in August and October they occurred in the southern inshore corner. The proposed CW intake fell within areas of low density (100-500/hectare) in June and August, and within an area of moderate density (500-1000/hectare) in October.

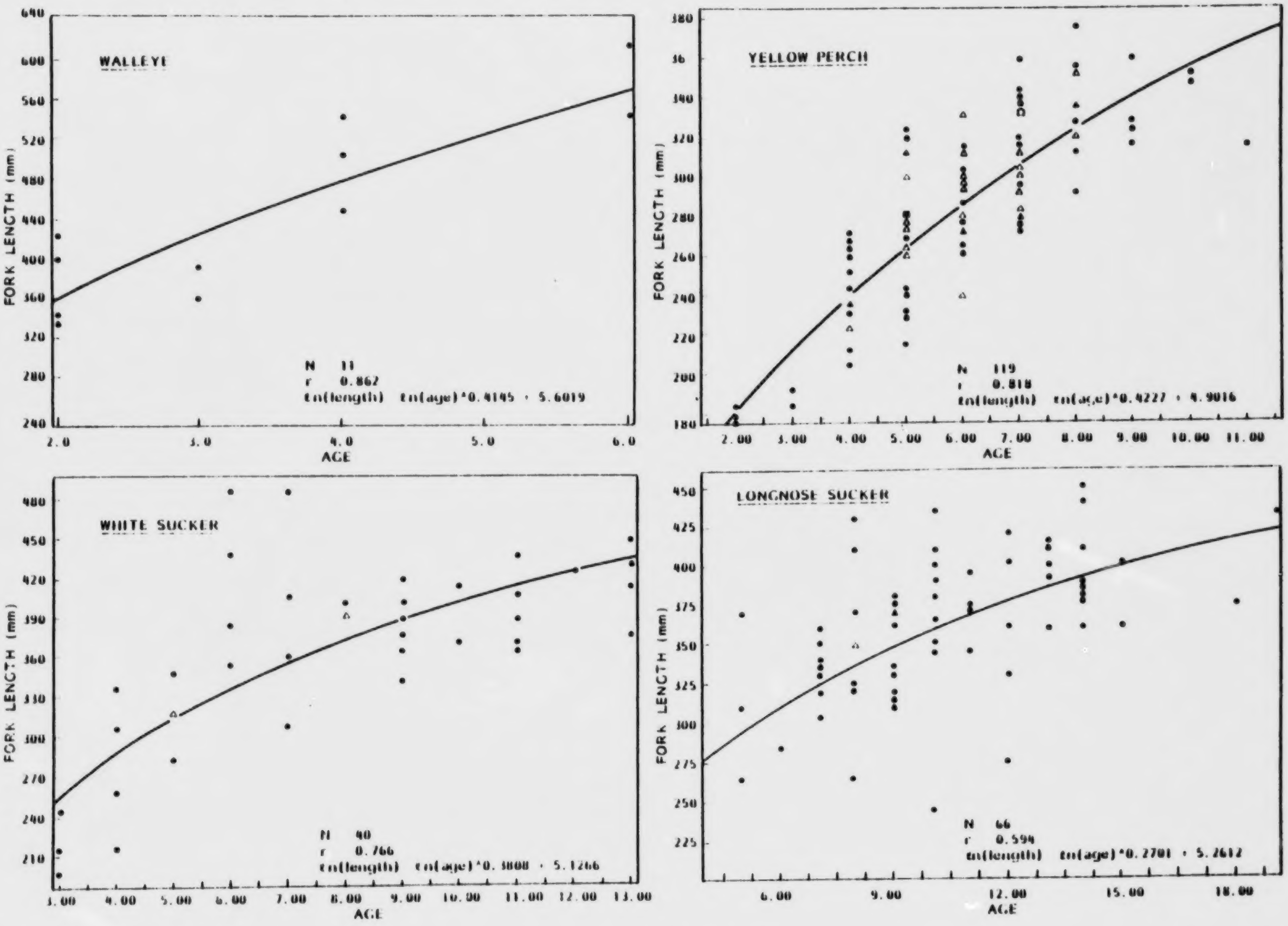


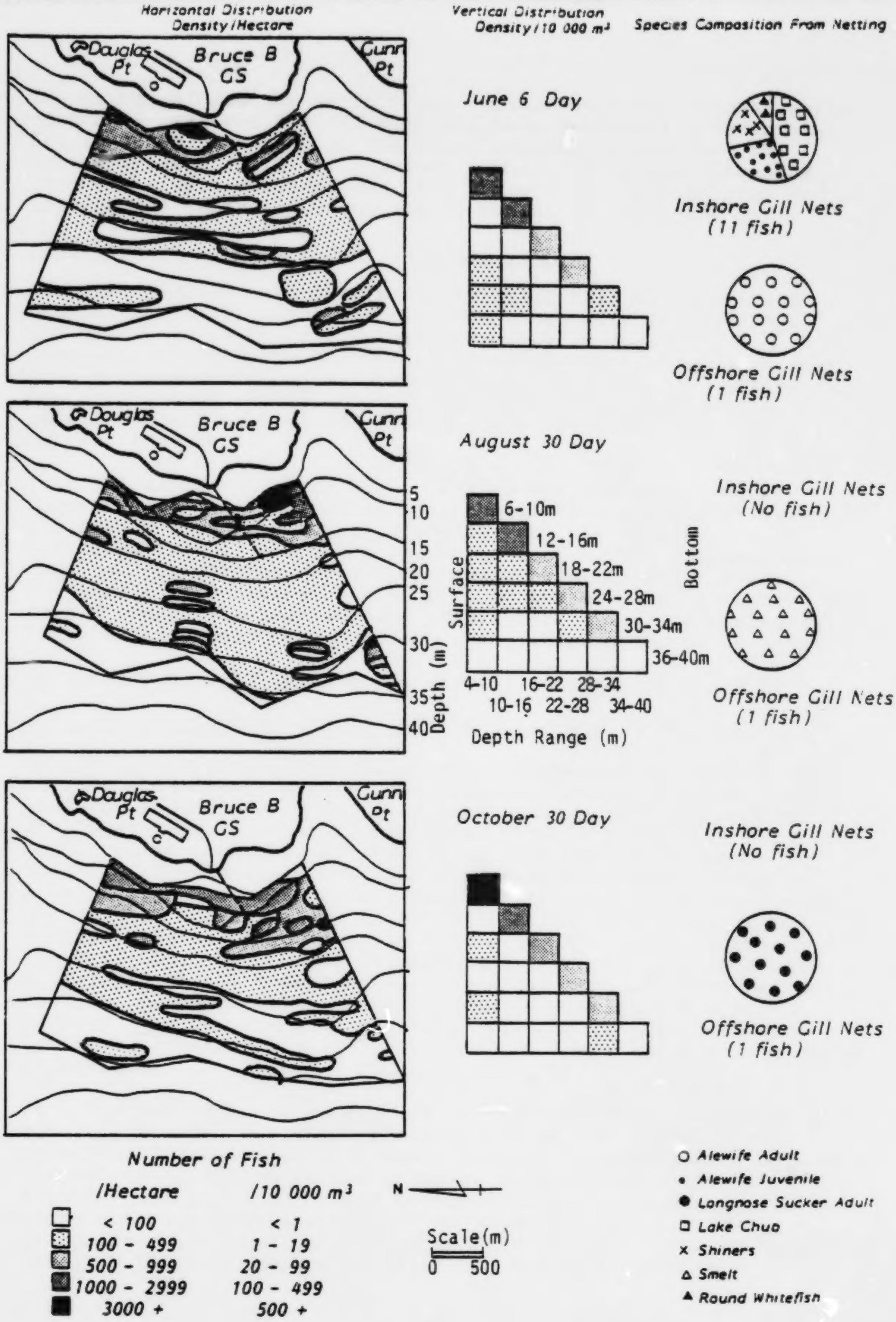
FIGURE 3.3.5-13

AGE-LENGTH RELATIONSHIPS OF FISH CAPTURED IN THE VICINITY OF BRUCE GS 'B' FROM MAY - NOVEMBER 1979

## Table 3.3.6-1

## MEAN FISH ECHO DENSITIES - NO/HECTARE
## BRUCE GS 'B' - 1979

| | | Transect | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sample | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Overall |
| Day | June 6 | 384 | 210 | 319 | 245 | 233 | 146 | 184 | 243 |
| | August 30 | 305 | 402 | 672 | 311 | 347 | 722 | 625 | 483 |
| | October 30 | 439 | 520 | 445 | 555 | 499 | 664 | 326 | 496 |
| Night | June 6 | 667 | 288 | 505 | 368 | 258 | 536 | 314 | 417 |
| | October 30 | 383 | 519 | 520 | 551 | 458 | 664 | 433 | 512 |



Horizontal Distribution Density/Hectare
Vertical Distribution Density/10 000 m³
Species Composition From Netting
Douglas Pt
Bruce B GS
Gunn Pt
June 6 Day
Inshore Gill Nets (11 fish)
Offshore Gill Nets (1 fish)
August 30 Day
Inshore Gill Nets (No fish)
Offshore Gill Nets (1 fish)
5
10
15
20
25
30
35
40
Depth (m)
6-10m
12-16m
18-22m
24-28m
30-34m
36-40m
Surface
Bottom
4-10
10-16
16-22
22-28
28-34
34-40
Depth Range (m)
October 30 Day
Inshore Gill Nets (No fish)
Offshore Gill Nets (1 fish)
Number of Fish
/Hectare
/10 000 m³
< 100
100 - 499
500 - 999
1000 - 2999
3000 +
< 1
1 - 19
20 - 99
100 - 499
500 +
N
Scale(m)
0
500
○ Alewife Adult
• Alewife Juvenile
● Longnose Sucker Adult
□ Lake Chub
× Shiners
△ Smelt
▲ Round Whitefish

FIGURE 3.3.6-1

ACOUSTICALLY DETERMINED FISH DISTRIBUTION AND NET CATCH AT BRUCE GS 'B' DURING THE DAY

The principal feature of vertical distribution was concentration of echoes near the bottom, with all mean densities greater than 500/10 000 $m^3$ obtained in the depth segments containing the bottom (Figure 3.3.6-1). Lesser numbers of echoes (100-500/ 10 000 $m^3$) were observed near the surface offshore in June and through the water column to the 30 m contour in August.

## Distribution of Fish Echoes in Night Samples

Acoustic samples were obtained after nightfall on June 6 and October 30. Horizontal distribution remained somewhat patchy, and continued to be greatest inshore (Figure 3.3.6-2). However, densities beyond the 25 m contour were somewhat higher than those observed in corresponding day samples. Densities at the proposed CW intake location were again low to moderate, being within ranges of 500-1000/hectare (June) and 500-1000/ hectare (October).

Vertical distribution at night in June was characterized by concentration of fish echoes near the surface as well as near the bottom (Figure 3.3.6-2), smaller numbers of echoes were scattered through the water column, except at the greatest depth sampled. In October, echoes were concentrated near the bottom, but were also scattered within 15 m of the surface throughout the sample area. The near surface echoes were primarily responsible for the relatively higher offshore densities observed by night.

Detailed echo density data are given in Appendices Q and R.

## Fish Species Composition for Acoustic Targets

Day and night acoustic surveys were accompanied by inshore and offshore gill netting along the middle transect (Figures 3.3.6-1 and -2c; Appendix S). The only substantial catch was made on June 6 at night in the inshore nets. The 247 fish were heavily dominated by adult alewife (14-17 cm fork length, Appendix T). Juvenile alewife (9-12 cm) with significant representation by lake chub and longnose sucker also contributed significantly to the catch. Approximately 90 of the alewfie were taken in the surface net, which would place them above the depth processed acoustically. By contrast, longnose sucker and lake chub were restricted to the bottom nets. The night time offshore net set (bottom) produced only a single juvenile alewife and a single burbot. The daytime gill net catch of only 12 fish included adult and juvenile alewife, lake chub, shiners and a single round whitefish.

Both the predominance of alewife in night netting associated with acoustic census, and their predominance in the conventional survey gill netting in that month suggested that alewife made the largest contribution to the observed fish echoes. Additional evidence was provided by the presence of moderate numbers of loose echo aggregations similar to those characteristically associated with alewife catches in Lake Ontario (Ontario Hydro Research Division Report 80-197-K) on the graphic record in the

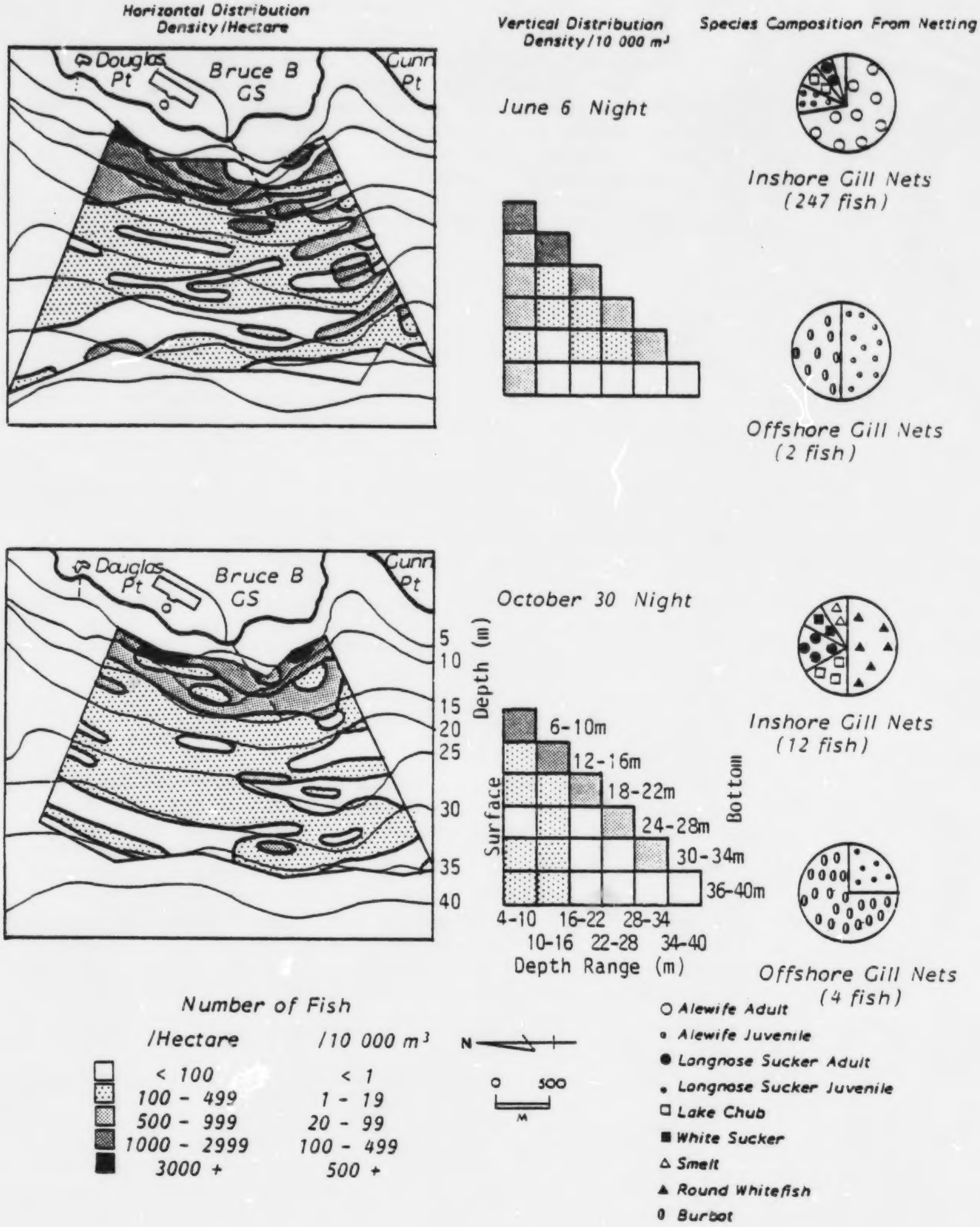


FIGURE 3.3.6-2

ACOUSTICALLY DETERMINED FISH DISTRIBUTION AND NET CATCH AT BRUCE GS 'B' DURING THE NIGHT daytime samples. From their vertical distribution in inshore netting it can also be suggested that alewife were also largely responsible for the fish echoes concentrated near the surface in the night sample. In addition, the observed density/hectare probably would have been much higher at night had the top 4 m of the water column been included. This appears to explain why acoustically-determined fish abundance was relatively low in June, while catches in conventional survey netting were relatively high.

Graphic records obtained both by day and night in June also revealed the presence of a number of large fish close to the bottom. The catches of longnose and white suckers in both acoustic survey and conventional netting suggest that these species contributed significantly to the observed echoes. This is supported by the behavioural observations of Emery (1973) which indicated that these suckers often swim far enough off the bottom to be resolved acoustically.

In August, only a single smelt was taken in the day set made in conjunction with the acoustic census. Gill nets were set at night as well, although that acoustic sample was interrupted by equipment failure. Species composition and distribution of the 65 fish caught was similar to that observed in June. The appearance and patterns of aggregation observed on the graphic record were also similar to those observed in June, and it can be assumed that the alewife and suckers again contributed the bulk of the observed echoes. The presence of a single smelt in offshore nets corresponded to the appearance of occasional dense echo aggregations typical of smelt in the offshore portion of the sampling grid.

In October, the inshore catch at night was relatively small (12 fish) and alewife were absent. The catch was dominated by large fish (round whitefish and suckers) and these species were also prominent in conventional survey netting. Examination of the graphic record also indicated that a relatively large proportion of near-bottom echoes could be attributed to large fish, although some loose aggregations typical of alewife, and some denser near-bottom aggregations typical of smelt were also present. The pelagic fish species contributing to the midwater echoes present by day and night cannot be identified.

## Influence of Temperature on Fish Distribution

Temperatures at the 0.5 m depth over the sample area varied by no more than 2°C during each acoustic sample (Appendix U). On June 6 (day) the north inshore corner of the sample grid was elevated by 2°C over the remainder of the site, possibly due to the Douglas Point GS/Heavy Water Plant discharge. Marginally higher temperatures (<1°C) were observed at the same location in the corresponding night sample. A general but slight inshore warming was observed in August, while horizontal variations in temperature in October were negligible.

Vertical temperature structure along the median transect on the three sampling days is shown in Figure 3.3.6-3 (Appendix V). On June 6 a relatively uniform temperature gradient impinged on the bottom with temperatures ranging from 4°C offshore to 9°C inshore. The 10°C isotherm did not contact the bottom of the sample area, remaining at 2 m.

On August 30 the water column was essentially isothermal at 17-18°C to the 20 m contour, but a marked gradient was observed beyond that point, with temperature dropping below 10°C at 33 m. On October 30, the water column was essentially isothermal at 10°C to the maximum depth examined (37 m).

Some aspects of the nearshore fish distribution in June and August may be at least partly attributed to temperature preference of alewife, the predominant species in those months.

A relatively strong concentration of alewife at the top of the sampled water column at night in June may be linked to an orientation of these fish to the warmest parts of the vertical gradient, since laboratory studies have indicated a spring temperature preferendum of approximately 20°C for adult alewife (Otto et al 1976, Reutter and Herdendorf 1974). Similarly, temperature elevations in the northern inshore corner of the sampling grid may have promoted concentration of alewife in that area, as suggested by the horizontal echo distribution in June day and night samples.

In August, fish echoes tended to be distributed through the water column in the inshore 2/3 of the transect, in which temperatures were generally 16-18°C. This range approximated the summer preferendum of 16°C for adult alewife, as determined by Otto et al (1976) in the laboratory. Brandt (1980) found near-bottom aggregations of alewife concentrated along temperature gradients in Lake Michigan in September, with adult alewife most abundant at 11-14°C. In the August sample, this temperature range impinged on the bottom in a relatively narrow band (approximately 200 m), but there was no evidence that fish were concentrated along it.

## 4.0 SUMMARY

1. Substrate composition at Bruce GS 'B' is primarily bedrock with cobble, boulder and pebble. The major substrate components at 3, 7 and 12 m were bedrock, boulder and cobble and cobble respectively.

2. Sedimentation was greater during August-November than in May-August. Total sediment accumulation along contours generally increased from 3 m to 7 m then decreased at 12 m in May-August. During August-November, no total sedimentation trends along contours were evident. Total sedimentation spatially was greatest along the Gunn Point (May-August)

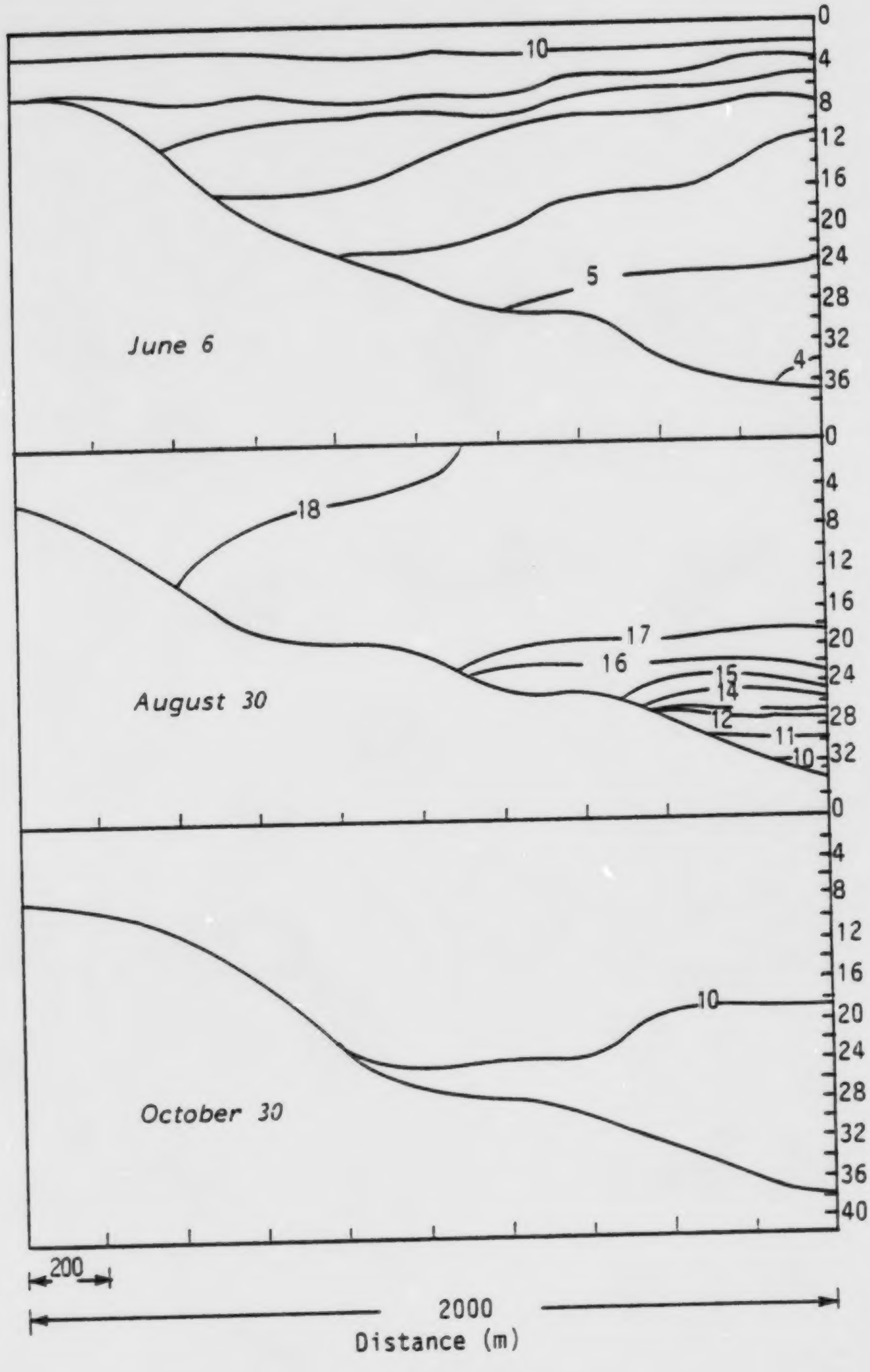


FIGURE 3.3.6-3

VERTICAL TEMPERATURE STRUCTURE AT BRUCE GS 'B' DURING ACOUSTIC FISH CENSUS - 1979

148650 RD

and Holmes Bay (August-November) transects. The per cent organic content was greater during May-August than during August-November, however, no trends were evident in per cent organic content with increasing depth. The per cent organic content was usually greatest along the Bruce GS 'B' intake and Bruce GS 'B' discharge transects.

3. Isothermal water temperatures were present on virtually all sampling dates at Biological Research sampling sites. The dissolved oxygen content was generally near or above saturation and similarly distributed through the water column. Secchi disc readings ranged from 1.6 m in May to 6.0 m in October.

4. Little variation was evident in most water quality parameters determined between sites or with season. The values were generally indicative of the low lake productivity within the Bruce GS 'B' area.

5. Heavy metal concentrations were generally greater in August than in November and were typical of reported Lake Huron heavy metal levels.

6. Substrate samples were not analyzed for heavy metals due to the large substrate size.

7. Highest phytoplankton biomass was found on June 6 followed by October 4 while lowest biomass was found on August 23. The Bacillariophyta was the main group present on June 6 and August 23, while the Cyanophyta was the main group present on October 4. Prominent taxa present on June 6 were *Rhizosolenia*, *Tabellaria fenestrata* and *Melosira granulata*. Unidentified pennales, *M. granulata* and *T. fenestrata* made up the largest portions of the phytoplankton biomass on August 23 while *Chroococcus* was the main taxon present on October 4.

   The distribution of phytoplankton assemblages did not appear to be related to temperature, nor were consistent trends in the distribution of assemblages obvious. On August 23, total phytoplankton density and the density of the main taxa were higher along the Bruce GS 'B' discharge transect than on the remaining transects. This distribution pattern was not related to the temperature distribution. No trends were obvious in the density distribution of the phytoplankton on July 6 or October 4.

8. Rotifers were most abundant on June 6, followed by October 4 and were least abundant on August 23. The main taxon present on June 6 was *Synchaeta* while on August 23 and October 4, *Conochilus unicornis* and *Trichotria tetractis* were the main taxa present respectively. The crustacean zooplankton were most abundant on August 23 followed by October 4 and were least abundant on June 6. The calanoid copepods made up the bulk of the crustacean zooplankton numbers on all these days. The main cladoceran present on

June 6 was *Bosmina longirostris* and on August 23 and October 4 it was *Daphnia galeata mendotae*. *Cyclops bicuspidatus thomasi* was the main cyclopoid copepod present on all three days.

The distribution of the rotifer and crustacean zooplankton assemblages, like the phytoplankton assemblages, did not appear to be related to temperature, nor were consistent trends in the distribution of the assemblages obvious.

On June 6 and August 23, most of the main zooplankton taxa occurred in higher abundances in the southern half of the study area especially along the South Boundary Point and Gunn Point transects. On October 4 their density distributions were heterogeneous with no obvious trends.

9. Generally the shoreline attached algae shifted from *Ulothrix zonata* dominance on June 6 to *Mougeotia* on October 4 with an absence of shoreline attached algae on August 9. There was an absence of 3 m attached algae on June 7. *Mougeotia* was dominant on the only three transects with attached algae on August 9 and on the four transects with attached algae on October 4. Monthly attached algae biomass was generally low. The attached algal biomass was greatest along the Bruce GS 'B' intake transect ($\bar{x}$ = 30 gm/m$^2$).

10. An average density of 224/m$^2$ was noted during June. Densities increased during October to an average 1438/m$^2$. The average number of taxa collected increased from 4.1 during June to 8 during October. The average diversity index increased from 1.61 during June to 1.97 during October.

    Among transects no consistent trend was apparent with depth for richness or diversity. Oligochaetes were most abundant during October. *Nais pardalis* was characteristic of shallow depths (1-7 m) while Tubificidae were present in samples from the 7-12 m depths. Chironomid larvae were most abundant during October. Peak concentrations for the dominant chironomid species were noted at depths between 1 m and 7 m.

11. The adult and juvenile fish community in the vicinity of Bruce GS 'B' was dominated by alewife, longnose sucker, lake chub, white sucker, spottail shiner, gizzard shad, yellow perch and round whitefish. The surface-pelagic and benthy-pelagic larval fish community was dominated by alewife and smelt with very limited numbers of burbot, Johnny darter and yellow perch making up most of the remainder.

    Densities of larval alewife, smelt and burbot did not differ significantly with depth contour or distance from shore. However, densities of juvenile and adult fish examined varied significantly with onshore-offshore and alongshore sample location. There appeared to be a general trend for juvenile and adult fish densities to decrease from north (Douglas Point) to south (Gunn Point).

Fish diversity in the vicinity of Bruce GS 'B' appeared to be similar to measurements made at other Great Lakes locations. Fish diversity varied significantly with season and onshore-offshore and alongshore sampling locations.

The age structure of walleye in the vicinity of Bruce GS 'B' may approximate a negative exponential expected for the whole population. Populations of yellow perch, white sucker and longnose sucker were dominated by adults, with sub-adult fish being virtually absent.

Gill net data suggest that alewife moved into and out of the sampling locations at relatively the same time in relatively the same magnitudes. In all other species examined, large-scale seasonal movements differed significantly among onshore-offshore and alongshore sampling locations. Onshore-offshore and alongshore movements of larval smelt and alewife also occurred in the vicinity of Bruce GS 'B'.

Species in the vicinity of Bruce GS 'B' during their spawning periods include longnose sucker, lake chub, white sucker, round whitefish, rainbow smelt, longnose dace, and common shiner.

The diet of yellow perch and white bass in the vicinity of Bruce GS 'B' may deviate significantly from the usual diet of these species. However, the diet of rainbow trout, walleye, longnose sucker and white sucker did not differ significantly from that reported in the literature.

Condition of yellow perch in the vicinity of Bruce GS 'B' was worse than in Long Point Bay, while condition of white sucker was better. Condition of walleye in the vicinity of Bruce GS 'B' was similar to condition of walleye in the Bay of Quinte, Lake Ontario.

Growth rates of walleye and yellow perch in the vicinity of Bruce GS 'B' was faster than that generally reported in the literature, while growth of white sucker and longnose sucker was slower than that generally reported in the literature.

12. Acoustically determined fish densities ranged from 243 to 512 per hectare during June, August and November sampling. Alewife and longnose and white suckers appeared to be the principal fish species counted.

By day, greatest fish echo densities were observed near shore and close to bottom, while at night, secondary concentrations attributed to alewife were seen in the upper portion of the water column. Alongshore, differences in echo density were not consistent from month to month. However, in June, higher densities in the northern inshore portion of the sampling area may have reflected attraction of alewife to the heated Douglas Point GS/Bruce Heavy Water Plant discharge.

| Approved: | Submitted: |
|---|---|
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| Manager | Biologist |
| Chemical Research Dept | Biological Research Section |

RWS:rdm

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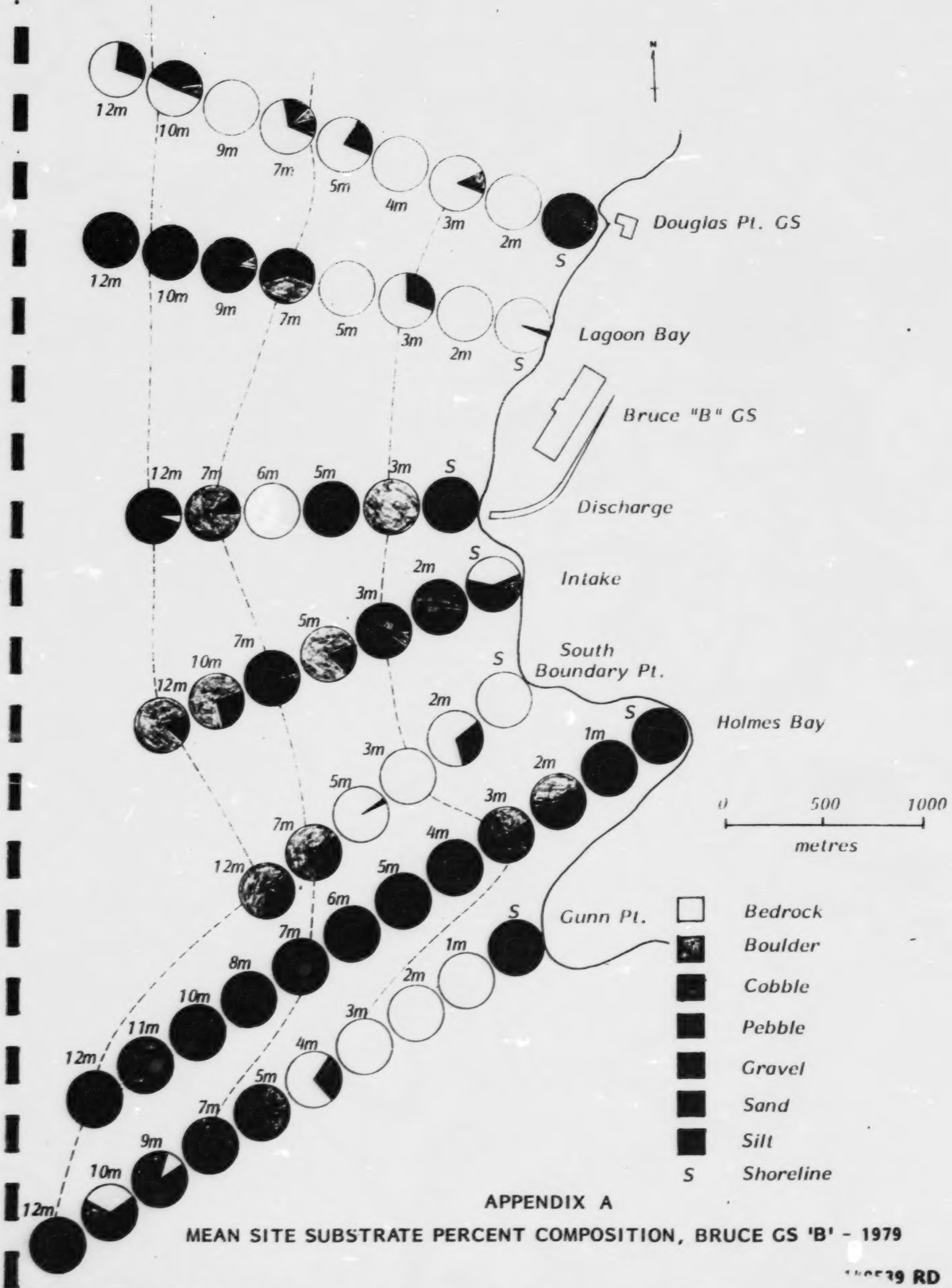
N
12m
10m
9m
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5m
4m
3m
2m
S
Douglas Pt. GS
12m
10m
9m
7m
5m
3m
2m
S
Lagoon Bay
Bruce "B" GS
12m
7m
6m
5m
3m
S
Discharge
S
Intake
2m
3m
5m
7m
10m
12m
South Boundary Pt.
S
2m
3m
5m
Holmes Bay
S
1m
2m
3m
4m
5m
6m
7m
8m
10m
11m
12m
7m
12m
0
500
1000
metres
Gunn Pt.
S
1m
2m
3m
4m
5m
7m
9m
10m
12m
☐ Bedrock
■ Boulder
■ Cobble
■ Pebble
■ Gravel
■ Sand
■ Silt
S Shoreline

APPENDIX A

MEAN SITE SUBSTRATE PERCENT COMPOSITION, BRUCE GS 'B' - 1979

[illegible]539 RD

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| DOUGLAS POINT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
| Shoreline | A | | | 68 | 22 | 10 | | | 0 | 0 |
| 1 m | A | 100 | | | | | | | 100 | 20 |
| 2 m | A | 100 | | | | | | | 70 | 0 |
| 3 m | A | 76 | 20 | | 4 | | | | 80 | 0 |
| | B | 100 | | | | | | | 70 | 0 |
| | $\overline{X}$ | 88 | 10 | | 2 | | | | 75 | 0 |
| 4 m | A | 100 | | | | | | | 0 | 0 |
| | B | 100 | | | | | | | 0 | 0 |
| | C | 100 | | | | | | | 90 | 0 |
| | $\overline{X}$ | 100 | | | | | | | 30 | 0 |
| 5 m | A | 12 | | 74 | 14 | | | | 50 | 0 |
| | B | 100 | | | | | | | 90 | 0 |
| | C | 100 | | | | | | | 80 | 0 |
| | D | 100 | | | | | | | 80 | 0 |
| | $\overline{X}$ | 78 | | 18 | 4 | | | | 75 | 0 |

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 m | A |  | 25 | 48 | 22 | 5 |  |  | 40 | 0 |
|  | B | 100 |  |  |  |  |  |  | 60 | 0 |
|  | C | 100 |  |  |  |  |  |  | 60 | 0 |
|  | $\overline{X}$ | 67 | 8 | 16 | 7 | 2 |  |  | 53 | 0 |
| 9 m | A | 100 |  |  |  |  |  |  | 80 | 0 |
| 10 m | A | 52 | 8 | 20 | 20 |  |  |  | 60 | 0 |
| 12 m | A | 74 |  | 10 | 16 |  |  |  | 0 | 0 |
|  |  |  |  | Bruce 'B' Discharge |  |  |  |  |  |  |
| Shoreline | A |  |  | 63 | 36 | 1 |  |  | 30 | 0 |
| 3 m | A |  | 100 |  |  |  |  |  | 0 | 0 |
| 5 m | A |  |  | 87 | 13 |  |  |  | 0 | 0 |
| 6 m | A | 100 |  |  |  |  |  |  | 60 | 0 |
| 7 m | A |  | 89 | 5 | 5 | 1 |  |  | 80 | 0 |
| 12 m | A | 5 |  | 90 | 4 | 1 |  |  | 40 | 0 |

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| Lagoon Bay | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
| Shoreline | A | 96 | | | 4 | | | | 80 | 10 |
| 2 m | A | 100 | | | | | | | 70 | 5 |
| 3 m | A | 100 | | | | | | | 0 | 0 |
| | B | 10 | | 50 | 39 | 1 | | | 70 | 0 |
| | C | 100 | | | | | | | 0 | 0 |
| | $\bar{X}$ | 70 | | 16 | 13 | 1 | | | 23 | 0 |
| 5 m | A | 100 | | | | | | | 0 | 0 |
| 7 m | A | | 40 | 40 | 18 | 2 | | | 70 | 0 |
| 9 m | A | | | 44 | 47 | 9 | | | 40 | 0 |
| 10 m | A | | | 46 | 53 | 1 | | | 25 | 0 |
| 12 m | A | | | 62 | 30 | 8 | | | 20 | 0 |

## APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
|---|---|---|---|---|---|---|---|---|---|---|
| Bruce 'B' Intake | | | | | | | | | | |
| Shoreline | A | 79 | | 1 | 12 | 4 | 4 | | 0 | 0 |
| | B | | | 42 | 44 | 12 | 2 | | 0 | 0 |
| | $\overline{X}$ | 40 | | 21 | 28 | 8 | 3 | | 0 | 0 |
| 2 m | A | | | 36 | 56 | 8 | | | 70 | 5 |
| 3 m | A | | | 50 | 34 | 10 | 6 | | 0 | 0 |
| 5 m | A | | 82 | 9 | 2 | | | | 0 | 0 |
| 7 m | A | | | 54 | 40 | 6 | | | 70 | 0 |
| 10 m | A | | 73 | 24 | 2 | 1 | | | 0 | 0 |
| 12 m | A | | 83 | 8 | 8 | 1 | | | 0 | 0 |
| South Boundary | | | | | | | | | | |
| Shoreline | A | 100 | | | | | | | 0 | 0 |
| 2 m | A | 69 | | 22 | 8 | 1 | | | 0 | 0 |
| 3 m | A | 100 | | | | | | | 0 | 0 |
| 5 m | A | 96 | | | 4 | | | | 40 | 0 |
| 7 m | A | | 67 | 9 | 24 | | | | 90 | 0 |

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| South Boundary | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
| 12 m | A | | 61 | 30 | 9 | | | | 90 | 0 |
| Holmes Bay | | | | | | | | | | |
| Shoreline | A | | | 77 | 21 | 2 | | | 0 | 0 |
| 1 m | A | | | 14 | 78 | 8 | | | 0 | 0 |
| | B | | | 48 | 44 | 8 | | | 10 | 5 |
| | C | | 19 | 48 | 18 | 15 | | | 30 | 5 |
| | $\overline{X}$ | | 6 | 37 | 47 | 10 | | | 13 | 3 |
| 2 m | A | | 92 | | 5 | 3 | | | 60 | 5 |
| | B | | 33 | 29 | 22 | 16 | | | 60 | 5 |
| | C | | 9 | 21 | 66 | 4 | | | 20 | 5 |
| | $\overline{X}$ | | 45 | 17 | 31 | 7 | | | 47 | 5 |
| 3 m | A | | 49 | | | | 51 | | 0 | 0 |
| | B | | 30 | 24 | 12 | | 34 | | 0 | 0 |
| | C | | | | | | 100 | | 0 | 0 |
| | $\overline{X}$ | | 26 | 8 | 4 | | 62 | | 0 | 0 |

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| Holmes Bay | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
| 4 m | A | | | 45 | 25 | | 30 | | 10 | 5 |
| | B | | | 98 | | | 2 | | 70 | 5 |
| | C | | | 3 | 24 | 2 | 71 | | 5 | 5 |
| | $\overline{X}$ | | | 49 | 16 | 1 | 34 | | 28 | 5 |
| 5 m | A | | | 16 | | | | 84 | 0 | 0 |
| | B | | | 46 | 4 | | | 50 | 0 | 0 |
| | C | | | 60 | 10 | | | 30 | 0 | 0 |
| | $\overline{X}$ | | | 41 | 5 | | | 54 | 0 | 0 |
| 6 m | A | | | | 5 | | | 95 | 0 | 0 |
| | B | | | | | | | 100 | 0 | 0 |
| | C | | | 14 | 14 | | | 72 | 0 | 0 |
| | $\overline{X}$ | | | 5 | 6 | | | 89 | 0 | 0 |
| 7 m | A | | | 36 | | | | 44 | 0 | 0 |
| | B | | | 90 | 9 | 1 | | | 0 | 0 |
| | C | | | 12 | | | | 88 | 0 | 0 |
| | $\overline{X}$ | | | 46 | 3 | 1 | | 50 | 0 | 0 |

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| Holmes Bay | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
| 8 m | A | | 4 | 44 | 18 | 8 | | 26 | 0 | 0 |
| | B | | 9 | 44 | 7 | | | 40 | 0 | 0 |
| | C | | | 86 | 3 | | | 11 | 0 | 0 |
| | $\bar{X}$ | | 3 | 58 | 9 | 3 | | 27 | 0 | 0 |
| 10 m | A | | | 62 | 30 | 8 | | | 30 | 0 |
| | B | | | 78 | 10 | 2 | | 10 | 0 | 0 |
| | C | | 10 | 77 | 12 | 1 | | | 10 | 0 |
| | $\bar{X}$ | | 3 | 73 | 17 | 4 | | 3 | 13 | 0 |
| 11 m | A | | | 79 | 17 | 1 | | 3 | 50 | 0 |
| | B | | | 42 | 48 | 10 | | | 10 | 0 |
| | C | | 48 | 42 | 10 | | | | 70 | 0 |
| | $\bar{X}$ | | 16 | 54 | 25 | 4 | | 1 | 43 | 0 |
| 12 m | A | | | 67 | 33 | | | | 10 | 0 |
| | B | | | 70 | 28 | 2 | | | 45 | 0 |
| | C | | | 80 | 20 | | | | 70 | 0 |
| | $\bar{X}$ | | | 72 | 27 | 1 | | | 42 | 0 |

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| Gunn Point | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
| Shoreline | A | | | 40 | 60 | | | | 0 | 0 |
| 1 m | A | 100 | | | | | | | 0 | 0 |
| 2 m | A | 100 | | | | | | | 0 | 0 |
| 3 m | A | 100 | | | | | | | 0 | 0 |
| | B | 100 | | | | | | | 0 | 0 |
| | C | 100 | | | | | | | 0 | 0 |
| | $\overline{X}$ | 100 | | | | | | | 0 | 0 |
| 4 m | A | 55 | 20 | 23 | 2 | | | | 0 | 0 |
| | B | 100 | | | | | | | 0 | 0 |
| | C | 57 | | 22 | 19 | 2 | | | 0 | 0 |
| | $\overline{X}$ | 70 | 7 | 15 | 7 | 1 | | | 0 | 0 |
| 5 m | A | | | 52 | 22 | 26 | | | 30 | 0 |
| | B | | | 53 | 23 | 24 | | | 15 | 0 |
| | C | | 40 | 11 | 23 | 26 | | | 20 | 0 |
| | $\overline{X}$ | | 13 | 39 | 23 | 25 | | | 22 | 0 |

# APPENDIX B

## SUBSTRATE PERCENT COMPOSITION

## BRUCE GS 'B' - 1979

| Gunn Point | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Replicate | Bedrock | Boulder | Cobble | Pebble | Gravel | Sand | Silt | % Algal Cover | % Living Algal Cover |
| 7 m | A | | | 65 | 19 | 10 | 6 | | 10 | 0 |
| | B | | 55 | 12 | 30 | 3 | | | 40 | 0 |
| | C | | 14 | 65 | 20 | 1 | | | 25 | 0 |
| | $\bar{X}$ | | 23 | 47 | 23 | 5 | 2 | | 25 | 0 |
| 9 m | A | | 56 | 22 | 22 | | | | 0 | 0 |
| | B | | 6 | | 12 | 82 | | | 0 | 0 |
| | C | 34 | 10 | 25 | 15 | 11 | 5 | | 0 | 0 |
| | $\bar{X}$ | 11 | 24 | 16 | 16 | 31 | 2 | | 0 | 0 |
| 10 m | A | | 39 | 38 | 8 | 10 | 5 | | 0 | 0 |
| | B | 100 | | | | | | | 0 | 0 |
| | C | | | 60 | 39 | 1 | | | 0 | 0 |
| | $\bar{X}$ | 33 | 13 | 33 | 16 | 4 | 1 | | 0 | 0 |
| 12 m | A | | | 72 | 24 | 4 | | | 0 | 0 |
| | B | | | 28 | 59 | 13 | | | 0 | 0 |
| | C | | 37 | 20 | 40 | 3 | | | 0 | 0 |
| | $\bar{X}$ | | 12 | 40 | 41 | 7 | | | 0 | 0 |

APPENDIX C

SUBSTRATE PARTICLE SIZE ANALYSIS

BRUCE GS 'B' - 1979

Bruce 'B' Discharge
3 m

| Sieve No | Opening mm | φ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | - | - | - | - |
| 10 | 2.00 | -0.91 | 865,7000 | 865.7000 | 91,3247 | 91.3247 |
| 18 | 1.00 | 0.06 | 27.4480 | 893.1480 | 2.8956 | 94.2203 |
| 35 | 0.500 | 1.04 | 20.0268 | 913.1748 | 2.1127 | 96.3330 |
| 60 | 0.250 | 2.01 | 25.9182 | 939.0930 | 2.7342 | 99.0672 |
| 120 | 0.125 | 2.98 | 6.0874 | 945.1804 | 0.6422 | 99.7094 |
| 230 | 0.063 | 3.95 | 1.3294 | 946.4098 | 0.1402 | 99.8496 |
| 400 | 0.038 | 4.66 | 0.1701 | 946.6799 | 0.0179 | 99.8675 |
| Pan | >0.038 | >4.66 | 1.2565 | 947.9364 | 0.1326 | 100 |

Bruce 'B' Discharge
7 m

| Sieve No | Opening mm | φ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | 363.4000 | 363.4000 | 56.6064 | 56.6064 |
| 10 | 2.00 | -0.91 | 278.4000 | 641.8000 | 43.3660 | 99.9724 |
| 18 | 1.00 | 0.06 | 0.0556 | 641.8556 | 0.0087 | 99.9811 |
| 35 | 0.500 | 1.04 | 0.0351 | 641.8907 | 0.0055 | 99.9866 |
| 60 | 0.250 | 2.01 | 0.0281 | 641.9188 | 0.0044 | 99.9910 |
| 120 | 0.125 | 2.98 | 0.0203 | 641.9391 | 0.0032 | 99.9942 |
| 230 | 0.063 | 3.95 | 0.0093 | 641.9484 | 0.0015 | 99.9957 |
| 400 | 0.038 | 4.66 | 0.0289 | 641.9773 | 0.0045 | 100 |
| Pan | >0.038 | >4.66 | - | - | - | - |

APPENDIX C

SUBSTRATE PARTICLE SIZE ANALYSIS

BRUCE GS 'B' - 1979

Bruce 'B' Intake
1 m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | - | - | - | - |
| 10 | 2.00 | -0.91 | - | - | - | - |
| 18 | 1.00 | 0.06 | - | - | - | - |
| 35 | 0.500 | 1.04 | - | - | - | - |
| 60 | 0.250 | 2.01 | - | - | - | - |
| 120 | 0.125 | 2.98 | - | - | - | - |
| 230 | 0.063 | 3.95 | 0.1149 | 0.1149 | 0.5597 | 0.5597 |
| 400 | 0.038 | 4.66 | 0.8308 | 0.0.9457 | 4.0470 | 4.6067 |
| Pan | >0.038 | >4.66 | 19.5831 | 20.5288 | 95.3933 | 100 |

Bruce 'B' Intake
3 m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | 247.9000 | 247.9000 | 30.0429 | 30.0429 |
| 10 | 2.00 | -0.91 | 570.5000 | 818.4000 | 69.1386 | 99.1815 |
| 18 | 1.00 | 0.06 | 4.2849 | 822.6849 | 0.5193 | 99.7008 |
| 35 | 0.500 | 1.04 | 1.1335 | 823.8184 | 0.1374 | 99.8382 |
| 60 | 0.250 | 2.01 | 0.8272 | 824.6456 | 0.1002 | 99.9384 |
| 120 | 0.125 | 2.98 | 0.2480 | 824.8936 | 0.0301 | 99.9685 |
| 230 | 0.063 | 3.95 | 0.0727 | 824.9663 | 0.0088 | 99.9773 |
| 400 | 0.038 | 4.66 | 0.0612 | 825.0275 | 0.0074 | 99.9847 |
| Pan | >0.038 | >4.66 | 0.1266 | 825.1541 | 0.0153 | 100 |

## APPENDIX C

### SUBSTRATE PARTICLE SIZE ANALYSIS

### BRUCE GS'B' - 1979

Bruce 'B' Intake
7 m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | 235.1000 | 235.1000 | 25.0013 | 25.0013 |
| 10 | 2.00 | -0.91 | 677.1000 | 912.2000 | 72.0051 | 97.0064 |
| 18 | 1.00 | 0.06 | 14.8676 | 927.0676 | 1.5810 | 98.5875 |
| 35 | 0.500 | 1.04 | 5.8796 | 932.9472 | 0.6253 | 99.2128 |
| 60 | 0.250 | 2.01 | 5.3365 | 938.2837 | 0.5675 | 99.7803 |
| 120 | 0.125 | 2.98 | 1.5240 | 939.8077 | 0.1621 | 99.9424 |
| 230 | 0.063 | 3.95 | 0.3513 | 940.1590 | 0.0374 | 99.9798 |
| 400 | 0.038 | 4.66 | 0.1257 | 940.2847 | 0.0134 | 99.9932 |
| Pan | >0.038 | >4.66 | 0.0650 | 940.3497 | 0.0069 | 100 |

South Boundary
12 m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | 571.6000 | 571.6000 | 68.7529 | 68.7529 |
| 10 | 2.00 | -0.91 | 259.0000 | 830.6000 | 31.1529 | 99.9058 |
| 18 | 1.00 | 0.06 | 0.0308 | 830.6308 | 0.0037 | 99.9095 |
| 35 | 0.500 | 1.04 | 0.0750 | 830.7050 | 0.0090 | 99.9185 |
| 60 | 0.250 | 2.01 | 0.0863 | 830.7921 | 0.0104 | 99.9289 |
| 120 | 0.125 | 2.98 | 0.1167 | 830.9088 | 0.0140 | 99.9429 |
| 230 | 0.063 | 3.95 | 0.1501 | 831.0589 | 0.0181 | 99.9610 |
| 400 | 0.038 | 4.66 | 0.1205 | 831.1799 | 0.0145 | 99.9755 |
| Pan | >0.038 | >4.66 | 0.2041 | 831.3825 | 0.0245 | 100 |

# APPENDIX C

## SUBSTRATE PARTICLE SIZE ANALYSIS

## BRUCE GS 'B' - 1979

Holmes Bay
1m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | 608.9000 | 608.9000 | 58.3174 | 58.3174 |
| 10 | 2.00 | -0.91 | 431.4000 | 1040.3000 | 41.3174 | 99.6348 |
| 18 | 1.00 | 0.06 | 1.8663 | 1042.1700 | 0.1787 | 99.8139 |
| 35 | 0.500 | 1.04 | 0.9228 | 1043.0900 | 0.0883 | 99.9020 |
| 60 | 0.250 | 2.01 | 0.1466 | 1043.2400 | 0.0140 | 99.9164 |
| 120 | 0.125 | 2.98 | 0.3646 | 1043.6040 | 0.0349 | 99.9512 |
| 230 | 0.063 | 3.95 | 0.2200 | 1043.8240 | 0.0211 | 99.9723 |
| 400 | 0.038 | 4.66 | 0.0976 | 1043.9216 | 0.0093 | 99.9816 |
| Pan | >0.038 | >4.66 | 0.1916 | 1044.1132 | 0.0002 | 100 |

Holmes Bay
3m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | - | - | - | - |
| 10 | 2.00 | -0.91 | 0.1061 | 0.1061 | 0.1234 | 0.1234 |
| 18 | 1.00 | 0.06 | 0.1651 | 0.2712 | 0.1920 | 0.3154 |
| 35 | 0.500 | 1.04 | 32.4100 | 32.6812 | 37.7068 | 38.0222 |
| 60 | 0.250 | 2.01 | 47.8846 | 80.5658 | 55.7104 | 93.7326 |
| 120 | 0.125 | 2.98 | 5.0332 | 85.5990 | 5.8558 | 99.5884 |
| 230 | 0.063 | 3.95 | 0.2879 | 85.8869 | 0.3350 | 99.9234 |
| 400 | 0.038 | 4.66 | 0.0153 | 85.9022 | 0.0178 | 99.9412 |
| Pan | >0.038 | >4.66 | 0.0505 | 85.9527 | 0.0588 | 100 |

## APPENDIX C

### SUBSTRATE PARTICLE SIZE ANALYSIS

### BRUCE GS 'B' - 1979

Holmes Bay
7 m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | - | - | - | - |
| 10 | 2.00 | -0.91 | 1.4104 | 1.4104 | 1.4303 | 1.4303 |
| 18 | 1.00 | 0.06 | 2.3655 | 3.7759 | 2.3989 | 3.8929 |
| 35 | 0.500 | 1.04 | 12.1772 | 15.9531 | 12.3493 | 16.1785 |
| 60 | 0.250 | 2.01 | 2.7358 | 67.1078 | 83.0609 | 84.2349 |
| 120 | 0.125 | 2.98 | 12.7367 | 95.7976 | 12.9167 | 97.1516 |
| 230 | 0.063 | 3.95 | 0.9065 | 96.7041 | 0.9193 | 98.0709 |
| 400 | 0.038 | 4.66 | 0.5993 | 97.3034 | 0.6078 | 98.6787 |
| Pan | >0.038 | >4.66 | 1.3028 | 98.6062 | 1.3212 | 100 |

Holmes Bay
12 m

| Sieve No | Opening mm | ϕ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | 441.4000 | 441.4000 | 64.6205 | 64.6205 |
| 10 | 2.00 | -0.91 | 241.4000 | 682.8000 | 35.3407 | 99.9612 |
| 18 | 1.00 | 0.06 | 0.0057 | 682.8057 | 0.0008 | 99.9620 |
| 35 | 0.500 | 1.04 | 0.0080 | 682.8137 | 0.0012 | 99.9632 |
| 60 | 0.250 | 2.01 | 0.0035 | 682.8172 | 0.0005 | 99.9637 |
| 120 | 0.125 | 2.98 | 0.0182 | 682.8354 | 0.0027 | 99.9664 |
| 230 | 0.063 | 3.95 | 0.0272 | 682.8676 | 0.0040 | 99.9704 |
| 400 | 0.038 | 4.66 | 0.0891 | 682.9517 | 0.0130 | 99.9834 |
| Pan | >0.038 | >4.66 | 0.1138 | 683.0655 | 0.0167 | 100 |

## APPENDIX C

## SUBSTRATE PARTICLE SIZE ANALYSIS

## BRUCE GS 'B' - 1979

### Gunn Point
12 m

| Sieve No | Opening mm | $\phi$ Units | Net Weight | Cumulative Weight | Individual % | Cumulative % |
|---|---|---|---|---|---|---|
| 1-1/4 | 31.5 | -4.79 | 408.6000 | 408.6000 | 39.0079 | 39.0079 |
| 10 | 2.00 | -0.91 | 592.1000 | 100.7000 | 56.5261 | 95.5340 |
| 18 | 1.00 | 0.06 | 20.1894 | 1020.8899 | 1.9274 | 97.4614 |
| 35 | 0.500 | 1.04 | 12.3459 | 1033.2353 | 1.1786 | 98.6400 |
| 60 | 0.250 | 2.01 | 8.1699 | 1041.4052 | 0.7800 | 99.4200 |
| 120 | 0.125 | 2.98 | 4.7755 | 1046.1807 | 0.4559 | 99.8759 |
| 230 | 0.063 | 3.95 | 1.0025 | 1047.1832 | 0.0957 | 99.9716 |
| 400 | 0.038 | 4.66 | 0.0284 | 1047.2116 | 0.0027 | 99.9743 |
| Pan | >0.038 | >4.66 | 0.2698 | 1047.4814 | 0.0258 | 100 |

## APPENDIX D

### TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

### MAY - AUGUST - BRUCE GS 'B' - 1979

### Douglas Point

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 17 | 3 | 1 | 30 | 0.3946 | 0.3713 | 94.10 | 0.0233 | 5.90 |
|  |  | 2 | 30 | 0.3793 | 0.3531 | 93.09 | 0.0262 | 6.91 |
|  |  | 3 | 30 | 0.3708 | 0.3443 | 92.83 | 0.0265 | 7.15 |
|  |  | 4 | 20 | 0.2173 | 0.2002 | 92.13 | 0.0171 | 7.87 |
| means |  |  | 27.5 | 0.3405 | 0.3172 | 93.04 | 0.0233 | 6.96 |
| 18 | 7 | 1 | 30 | 0.2898 | 0.2616 | 90.27 | 0.0283 | 9.77 |
|  |  | 2 | 50 | 0.3634 | 0.3349 | 92.16 | 0.0285 | 7.84 |
|  |  | 3 | 50 | 0.2557 | 0.2379 | 93.04 | 0.0178 | 6.96 |
|  |  | 4 | 20 | 0.1438 | 0.1322 | 91.93 | 0.0116 | 8.07 |
| means |  |  | 37.5 | 0.2632 | 0.2417 | 91.85 | 0.0216 | 8.16 |
| 19 | 12 | 1 | 10 | 0.1864 | 0.1737 | 93.19 | 0.0127 | 6.81 |
|  |  | 2 | 10 | 0.1827 | 0.1711 | 93.65 | 0.0116 | 6.35 |
|  |  | 3 | 10 | 0.1733 | 0.1573 | 90.77 | 0.0160 | 9.23 |
|  |  | 4 | 10 | 0.1581 | 0.1457 | 92.16 | 0.0124 | 7.84 |
| means |  |  | 10 | 0.1751 | 0.1620 | 92.44 | 0.0132 | 7.56 |

# APPENDIX D

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

## MAY - AUGUST - BRUCE GS 'B' - 1979

### Lagoon Bay

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 20 | 3 | 1 | 10 | 0.2599 | 0.2420 | 93.11 | 0.0179 | 6.89 |
| | | 2 | 50 | 0.7041 | 0.6536 | 92.83 | 0.0505 | 7.17 |
| | | 3 | 10 | 0.2360 | 0.2206 | 93.47 | 0.0154 | 6.53 |
| | | 4 | 10 | 0.1797 | 0.1673 | 93.10 | 0.0123 | 6.84 |
| means | | | 20 | 0.3449 | 0.3209 | 93.13 | 0.0240 | 6.86 |
| 110 | 7 | 1 | 50 | 0.6171 | 0.5789 | 93.81 | 0.0382 | 6.19 |
| | | 2 | 40 | 0.6326 | 0.5903 | 93.31 | 0.0423 | 6.69 |
| | | 3 | 10 | 0.1463 | 0.1342 | 91.73 | 0.0121 | 8.27 |
| | | 4 | 40 | 0.6394 | 0.5979 | 93.51 | 0.0415 | 6.49 |
| means | | | 35 | 0.5089 | 0.4753 | 93.09 | 0.0335 | 6.91 |
| 111 | 12 | 1 | 20 | 0.4467 | 0.4142 | 92.72 | 0.0325 | 7.28 |
| | | 2 | 30 | 0.5845 | 0.5477 | 93.70 | 0.0368 | 6.30 |
| | | 3 | 30 | 0.7084 | 0.6840 | 96.56 | 0.0244 | 3.44 |
| means | | | 26.67 | 0.5799 | 0.5486 | 94.33 | 0.0312 | 5.67 |

## APPENDIX D

### TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm²)

### MAY - AUGUST, BRUCE GS 'B' - 1979

### Bruce 'B' Discharge

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm²) | Inorganic (gm/cm²) | % Inorganic | Organic (gm/cm²) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 21 | 3 | 1 | 50 | 0.6729 | 0.6357 | 94.47 | 0.0372 | 5.52 |
| | | 2 | 60 | 1.2869 | 1.2228 | 95.01 | 0.0641 | 4.98 |
| | | 3 | 20 | 0.6904 | 0.6435 | 93.20 | 0.0468 | 6.77 |
| | | 4 | 60 | 1.1552 | 1.1052 | 95.67 | 0.0499 | 4.31 |
| means | | | 47.5 | 0.9513 | 0.9018 | 94.59 | 0.0495 | 5.40 |
| 22 | 7 | 1 | 20 | 0.3586 | 0.3127 | 87.20 | 0.0458 | 12.77 |
| | | 2 | 20 | 0.4693 | 0.4334 | 92.36 | 0.0358 | 7.63 |
| | | 3 | 30 | 0.3985 | 0.3598 | 90.28 | 0.0386 | 9.68 |
| | | 4 | 30 | 0.2360 | 0.2085 | 88.34 | 0.0275 | 11.65 |
| means | | | 25 | 0.3655 | 0.3286 | 89.55 | 0.0369 | 10.43 |
| 23 | 12 | 1 | 20 | 0.2961 | 0.2726 | 92.06 | 0.0235 | 7.93 |
| | | 2 | 10 | 0.2168 | 0.1987 | 91.65 | 0.0180 | 8.30 |
| | | 3 | 30 | 0.3947 | 0.3574 | 90.54 | 0.0372 | 9.42 |
| | | 4 | 30 | 0.3342 | 0.3075 | 92.01 | 0.0266 | 7.95 |
| means | | | 22.5 | 0.3104 | 0.2840 | 91.57 | 0.0263 | 8.40 |

# APPENDIX D

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

## MAY - AUGUST, BRUCE GS 'B' - 1979

### Bruce 'B' Intake

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 24 | 3 | 1 | 20 | 0.3644 | 0.3325 | 91.25 | 0.0320 | 8.78 |
| | | 2 | 20 | 0.2658 | 0.2522 | 94.88 | 0.0136 | 5.12 |
| | | 3 | 30 | 0.4153 | 0.3862 | 92.99 | 0.0290 | 6.98 |
| | | 4 | 10 | 0.0699 | 0.0640 | 91.56 | 0.0059 | 8.44 |
| means | | | 20 | 0.2789 | 0.2587 | 92.67 | 0.0201 | 7.33 |
| 25 | 7 | 1 | 15 | 0.3051 | 0.2814 | 91.9 | 0.0237 | 7.77 |
| | | 2 | 20 | 0.2612 | 0.2385 | 91.31 | 0.0227 | 8.69 |
| | | 3 | 20 | 0.2936 | 0.2694 | 91.76 | 0.0241 | 8.21 |
| | | 4 | 20 | 0.2807 | 0.2571 | 91.59 | 0.0237 | 8.44 |
| means | | | 18.75 | 0.2852 | 0.2616 | 91.64 | 0.0236 | 8.28 |
| 26 | 12 | 1 | 5 | 0.1007 | 0.0918 | 91.16 | 0.0089 | 8.84 |
| | | 2 | 10 | 0.0747 | 0.0682 | 91.30 | 0.0065 | 8.70 |
| | | 3 | 10 | 0.2089 | 0.1919 | 91.86 | 0.0170 | 8.14 |
| means | | | 8.3 | 0.1281 | 0.1173 | 91.44 | 0.0108 | 8.56 |

## APPENDIX D

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION ($gm/cm^2$)

## MAY - AUGUST, BRUCE GS 'B' - 1979

### South Boundary Point

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total ($gm/cm^2$) | Inorganic ($gm/cm^2$) | % Inorganic | Organic ($gm/cm^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 27 | 3 | 1 | 30 | 0.4678 | 0.4360 | 93.20 | 0.0317 | 6.77 |
|  |  | 2 | 40 | 0.8399 | 0.7719 | 91.90 | 0.0679 | 8.08 |
|  |  | 3 | 20 | 0.5180 | 0.4781 | 92.29 | 0.0398 | 7.68 |
|  |  | 4 | 30 | 0.3090 | 0.2895 | 93.68 | 0.0195 | 6.31 |
| means |  |  | 30 | 0.5336 | 0.4938 | 92.77 | 0.0397 | 7.21 |
| 28 | 7 | 1 | 30 | 0.3956 | 0.3595 | 90.87 | 0.0361 | 9.12 |
|  |  | 2 | 20 | 0.4935 | 0.4581 | 92.82 | 0.0353 | 7.15 |
|  |  | 3 | 25 | 0.4055 | 0.3726 | 92.37 | 0.0308 | 7.59 |
| means |  |  | 25 | 0.4315 | 0.3974 | 92.02 | 0.0340 | 7.95 |
| 29 | 12 | 1 | 10 | 0.1845 | 0.1683 | 91.22 | 0.0161 | 8.73 |
|  |  | 2 | 10 | 0.1873 | 0.1715 | 91.56 | 0.0157 | 8.38 |
|  |  | 3 | 10 | 0.1446 | 0.1356 | 93.78 | 0.0090 | 6.22 |
|  |  | 4 | 10 | 0.1397 | 0.1252 | 89.62 | 0.0145 | 10.38 |
| means |  |  | 10 | 0.1640 | 0.1502 | 91.55 | 0.0138 | 8.43 |

## APPENDIX D

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

## MAY - AUGUST, BRUCE GS 'B' - 1979

### Holmes Bay

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 30 | 3 | 1 | 80 | 0.9795 | 0.9206 | 93.99 | 0.0589 | 6.01 |
| | | 2 | 80 | 0.0631 | 0.9021 | 93.67 | 0.0611 | 6.34 |
| | | 3 | 70 | 1.0034 | 0.9377 | 93.45 | 0.0658 | 6.56 |
| | | 4 | 60 | 1.0317 | 0.9680 | 93.83 | 0.0636 | 6.16 |
| means | | | 72.5 | 0.9944 | 0.9321 | 93.74 | 0.0624 | 6.27 |
| 31 | 7 | 1 | 90 | 1.4139 | 1.3393 | 94.72 | 0.0746 | 5.28 |
| | | 2 | 105 | 1.7536 | 1.6592 | 94.62 | 0.0944 | 5.38 |
| | | 3 | 40 | 0.7959 | 0.7632 | 95.89 | 0.0327 | 4.11 |
| | | 4 | 100 | 1.7845 | 1.6966 | 95.07 | 0.0880 | 4.93 |
| means | | | 83.75 | 1.4370 | 1.3646 | 95.075 | 0.0724 | 4.93 |
| 32 | 12 | 1 | 20 | 0.3694 | 0.3430 | 92.85 | 0.0264 | 7.15 |
| | | 2 | 40 | 0.6534 | 0.5962 | 91.25 | 0.0572 | 8.75 |
| | | 3 | 30 | 0.5742 | 0.5388 | 93.83 | 0.0354 | 6.17 |
| | | 4 | 40 | 0.6944 | 0.6512 | 93.78 | 0.0432 | 6.22 |
| means | | | 32.5 | 0.5729 | 0.5323 | 92.93 | 0.0406 | 7.07 |

# APPENDIX D

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

## MAY - AUGUST, BRUCE GS 'B' - 1979

### Gunn Point

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 105 | 3 | 1 | 40 | 0.5496 | 0.5072 | 92.29 | 0.0424 | 7.71 |
| | | 2 | 40 | 0.5213 | 0.4829 | 92.63 | 0.0384 | 7.37 |
| | | 3 | 20 | 0.1551 | 0.1433 | 92.39 | 0.0118 | 7.61 |
| | | 4 | 20 | 0.4795 | 0.4478 | 93.39 | 0.0317 | 6.61 |
| means | | | 30 | 0.4264 | 0.3953 | 92.68 | 0.0311 | 7.33 |
| 106 | 7 | 1 | 20 | 2.8081 | 2.8526 | 98.77 | 0.0356 | 1.23 |
| | | 2 | 20 | 2.1538 | 2.1155 | 98.22 | 0.0383 | 1.78 |
| | | 3 | 30 | 2.6989 | 2.6564 | 98.43 | 0.0425 | 1.57 |
| | | 4 | 20 | 3.0136 | 2.9810 | 98.92 | 0.0327 | 1.09 |
| means | | | 22.5 | 2.6886 | 2.6514 | 98.59 | 0.0373 | 1.42 |
| 107 | 12 | 1 | 5 | 0.1319 | 0.1210 | 91.74 | 0.0109 | 8.26 |
| | | 2 | 20 | 0.1851 | 0.1693 | 91.46 | 0.0159 | 8.59 |
| | | 3 | 10 | 0.1644 | 0.1486 | 90.39 | 0.0157 | 9.55 |
| | | 4 | 20 | 0.1904 | 0.1733 | 91.02 | 0.0171 | 8.98 |
| means | | | 13.75 | 0.1680 | 0.1531 | 91.15 | 0.0149 | 8.85 |

## APPENDIX E

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

### AUGUST - NOVEMBER, BRUCE GS 'B' - 1979

### Douglas Point

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 17 | 3 m | 1 | 70 | 1.4198 | 1.3431 | 94.5971 | 0.0767 | 5.40 |
|  |  | 2 | 50 | 1.3124 | 1.2212 | 93.0510 | 0.0912 | 6.95 |
|  |  | 3 | 50 | 1.1392 | 1.0797 | 94.7740 | 0.0595 | 5.22 |
|  |  | 4 | 100 | 1.0757 | 1.0206 | 94.8736 | 0.0552 | 5.13 |
| means |  |  | 68 | 1.2368 | 1.1662 | 94.3239 | 0.0706 | 5.68 |
| 18 | 7 m | 1 | 180 | 3.8874 | 2.5588 | 65.8229 | 1.3287 | 34.18 |
| 19 | 12 m | 1 | 80 | 1.5218 | 1.4440 | 94.8876 | 0.0778 | 5.11 |
|  |  | 2 | 140 | 2.8504 | 2.6885 | 94.3201 | 0.1619 | 5.68 |
|  |  | 3 | 110 | 2.6069 | 2.4715 | 94.8059 | 0.1354 | 5.20 |
|  |  | 4 | 130 | 2.6719 | 2.5156 | 94.1495 | 0.1563 | 5.85 |
| means |  |  | 115 | 2.4128 | 2.2799 | 94.5408 | 0.1153 | 5.46 |

# APPENDIX E

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm²)

## AUGUST - NOVEMBER, BRUCE GS 'B' - 1979

### Lagoon Bay

| SPAR | Depth (m) | Tube | Total Volume (mL) | Total (gm/cm²) | Inorganic (gm/cm²) | % Inorganic | Organic (gm/cm²) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 20 | 3 m | 1 | 180 | 6.2474 | 5.9046 | 94.5126 | 0.3169 | 5.07 |
| | | 2 | 170 | 4.2664 | 4.0008 | 93.7745 | 0.2656 | 6.23 |
| | | 3 | 200 | 4.3116 | 4.0556 | 94.0631 | 0.2560 | 5.94 |
| means | | | 183 | 4.9418 | 4.6537 | 94.1167 | 0.2795 | 5.75 |
| 110 | 7 m | 1 | 130 | 3.7230 | 3.5876 | 96.3643 | 0.1354 | 3.64 |
| | | 2 | 130 | 3.3700 | 3.2230 | 95.6380 | 0.1469 | 4.36 |
| | | 3 | 150 | 3.2068 | 3.0355 | 94.6592 | 0.1713 | 5.34 |
| | | 4 | 150 | 6.4262 | 6.1926 | 96.3650 | 0.2236 | 3.63 |
| means | | | 140 | 4.1815 | 4.0097 | 95.7566 | 0.1693 | 4.24 |
| 111 | 12 m | 1 | 380 | 10.4395 | 9.8969 | 94.8023 | 0.5426 | 5.20 |
| | | 2 | 410 | 9.4615 | 8.9208 | 94.2850 | 0.5408 | 5.72 |
| | | 3 | 410 | 9.7796 | 9.2820 | 94.9116 | 0.4976 | 5.09 |
| | | 4 | 280 | 3.0877 | 2.9475 | 95.4592 | 0.1402 | 4.54 |
| means | | | 370 | 8.1371 | 7.7618 | 94.8645 | 0.4303 | 5.14 |

## APPENDIX E

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION ($gm/cm^2$)

## AUGUST - NOVEMBER, BRUCE GS 'B' - 1979

### Bruce 'B' Discharge

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total ($gm/cm^2$) | Inorganic ($gm/cm^2$) | % Inorganic | Organic ($gm/cm^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 21 | 3 m | 1 | 90 | 2.1387 | 2.0369 | 95.2401 | 0.1017 | 4.76 |
| | | 2 | 140 | 3.2176 | 3.0579 | 95.0374 | 0.1596 | 4.96 |
| | | 3 | 100 | 2.0799 | 1.9798 | 95.1890 | 0.1000 | 4.81 |
| | | 4 | 100 | 2.0888 | 1.9855 | 95.0566 | 0.1032 | 4.94 |
| means | | | 108 | 2.3812 | 2.2650 | 95.1308 | 0.1161 | 4.87 |
| 22 | 7 m | 1 | 95 | 1.6346 | 1.5363 | 93.9838 | 0.0984 | 6.02 |
| | | 2 | 110 | 1.9294 | 1.8068 | 93.6459 | 0.1226 | 6.35 |
| | | 3 | 75 | 1.5521 | 1.4641 | 94.3320 | 0.0880 | 5.67 |
| | | 4 | 100 | 1.6868 | 1.5786 | 93.5835 | 0.1083 | 6.42 |
| means | | | 95 | 1.7007 | 1.5964 | 93.8863 | 0.1043 | 6.11 |
| 23 | 12 m | 1 | 70 | 1.3407 | 1.2509 | 93.3014 | 0.0898 | 6.70 |
| | | 2 | 50 | 1.0424 | 0.9670 | 92.7634 | 0.0754 | 7.24 |
| means | | | 60 | 1.1916 | 1.1090 | 93.0324 | 0.0826 | 6.97 |

## APPENDIX E

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm²)

### AUGUST - NOVEMBER, BRUCE GS 'B' - 1979

### Bruce 'B' Intake

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm²) | Inorganic (gm/cm²) | % Inorganic | Organic (gm/cm²) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 24 | 3 m | 1 | 120 | 2.6502 | 2.5519 | 96.2925 | 0.0982 | 3.71 |
| | | 2 | 125 | 3.1618 | 3.0558 | 96.6485 | 0.1060 | 3.35 |
| means | | | 122.5 | 2.9060 | 2.8039 | 96.4705 | 0.1021 | 3.53 |
| 25 | 7 m | 1 | 110 | 2.2608 | 2.1051 | 93.1132 | 0.1557 | 6.89 |
| | | 2 | 110 | 2.1947 | 2.0331 | 92.6370 | 0.1616 | 7.37 |
| | | 3 | 140 | 2.3014 | 2.1652 | 94.0819 | 0.1363 | 5.92 |
| | | 4 | 120 | 2.2835 | 2.1487 | 94.0968 | 0.1348 | 5.90 |
| means | | | 120 | 2.2601 | 2.1130 | 93.4822 | 0.1471 | 6.52 |
| 26 | 12 m | 1 | 45 | 0.9880 | 0.9198 | 93.0972 | 0.0682 | 6.90 |
| | | 2 | 50 | 0.9745 | 0.9067 | 93.0461 | 0.0678 | 6.95 |
| | | 3 | 90 | 1.0411 | 1.0347 | 99.3810 | 0.0064 | 0.61 |
| | | 4 | 50 | 1.1732 | 0.9582 | 81.6760 | 0.2150 | 18.32 |
| means | | | 59 | 1.0442 | 0.9548 | 91.8001 | 0.0894 | 8.20 |

## APPENDIX E

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm²)

## AUGUST - NOVEMBER, BRUCE GS 'B'- 1979

### South Boundary Point

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm²) | Inorganic (gm/cm²) | % Inorganic | Organic (gm/cm²) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 28 | 7 m | 1 | 15 | 0.2911 | 0.2744 | 94.2547 | 0.0167 | 5.75 |
| | | 2 | 160 | 3.6383 | 3.4276 | 94.2091 | 0.2106 | 5.79 |
| | | 3 | 100 | 1.1453 | 1.0833 | 94.5865 | 0.0620 | 5.41 |
| means | | | 92 | 1.6916 | 1.5951 | 94.3501 | 0.0964 | 5.65 |
| 29 | 12 m | 1 | 80 | 1.5942 | 1.4996 | 94.0665 | 0.0946 | 5.93 |
| | | 2 | 100 | 2.0360 | 1.9354 | 95.0577 | 0.1006 | 4.94 |
| | | 3 | 110 | 2.1783 | 2.0733 | 95.1796 | 0.1050 | 4.82 |
| | | 4 | 90 | 1.8473 | 1.7402 | 94.2034 | 0.1071 | 5.80 |
| means | | | 95 | 1.9140 | 1.8121 | 94.6268 | 0.1018 | 5.37 |

## APPENDIX E

## TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

## AUGUST - NOVEMBER, BRUCE GS 'B' - 1979

### Holmes Bay

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 30 | 3 m | 1 | 800 | 34.6417 | 33.7902 | 97.5419 | 0.8516 | 2.46 |
| | | 2 | 775 | 24.3941 | 23.9535 | 98.1936 | 0.4406 | 1.81 |
| | | 3 | 750 | 30.0962 | 29.3569 | 97.5435 | 0.7393 | 2.46 |
| | | 4 | 800 | 31.0321 | 30.1698 | 97.2212 | 0.8624 | 2.78 |
| means | | | 781 | 30.0410 | 29.3176 | 97.6250 | 0.7235 | 2.38 |
| 31 | 7 m | 1 | 950 | 39.7622 | 38.4505 | 96.7011 | 1.3117 | 3.30 |
| | | 2 | 950 | 38.0908 | 36.8946 | 96.8596 | 1.1962 | 3.14 |
| | | 3 | 900 | 36.9164 | 35.8666 | 97.1563 | 1.0351 | 2.80 |
| means | | | 933 | 38.2565 | 37.0706 | 96.9057 | 1.1810 | 3.08 |
| 32 | 12 m | 1 | 320 | 8.9376 | 8.5206 | 95.3340 | 0.4170 | 4.67 |
| | | 2 | 490 | 6.8486 | 6.4589 | 94.3098 | 0.3897 | 5.69 |
| means | | | 405 | 7.7118 | 7.4898 | 94.8219 | 0.4034 | 5.18 |

## APPENDIX E

### TOTAL, INORGANIC AND ORGANIC SEDIMENTATION (gm/cm$^2$)

### AUGUST - NOVEMBER, BRUCE GS 'B' - 1979

### Gunn Point

| SPAR | Depth (m) | Tube | Total Volume (ml) | Total (gm/cm$^2$) | Inorganic (gm/cm$^2$) | % Inorganic | Organic (gm/cm$^2$) | % Organic |
|---|---|---|---|---|---|---|---|---|
| 110 | 7 m | 1 | 120 | 3.1558 | 3.0086 | 95.3357 | 0.1471 | 4.66 |
| | | 2 | 130 | 3.5921 | 3.3823 | 94.1594 | 0.2098 | 5.84 |
| | | 3 | 120 | 3.4859 | 3.3035 | 94.7675 | 0.1824 | 5.23 |
| | | 4 | 110 | 2.9362 | 2.7671 | 94.2404 | 0.1691 | 5.76 |
| means | | | 120 | 3.2925 | 3.1154 | 94.6258 | 0.1771 | 5.38 |

# APPENDIX F

## DISSOLVED OXYGEN & TEMPERATURE PROFILES AT SPAR 26

## BRUCE GS 'B' 1979

Temp = °C

DO = ppm

| Depth | May 18 |  | June 7 |  | July 24 |  | August 23 |  | September 27 |  | October 31 |  | November 21 |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Temp | DO | Temp | DO | Temp | DO | Temp | DO | Temp | DO | Temp | DO | Temp | DO |
| Surface | 8.3 | 10.3 | 10.0 | 13.0 | 19.2 | 10.2 | 16.5 | 8.4 | 17.0 | 9.9 | 11.0 | 10.6 | 8.0 | 10.5 |
| 1 m | 8.3 | 10.4 | 9.8 | 13.0 | 19.2 | 10.2 | 16.5 | 9.0 | 15.5 | 9.9 | 11.2 | 10.6 | 8.0 | 11.2 |
| 2 m | 8.3 | 10.4 | 9.8 | 13.0 | 19.0 | 10.3 | 16.5 | 9.0 | 15.5 | 10.0 | 11.2 | 10.6 | 8.0 | 11.6 |
| 3 m | 8.3 | 10.4 | 9.8 | 13.0 | 19.0 | 10.2 | 16.2 | 9.1 | 15.5 | 10.0 | 11.3 | 10.6 | 8.0 | 11.6 |
| 4 m | 8.3 | 10.4 | 9.5 | 13.0 | 18.5 | 10.2 | 16.2 | 9.1 | 15.5 | 10.0 | 11.3 | 10.6 | 8.0 | 11.6 |
| 5 m | 8.3 | 10.4 | 9.5 | 13.0 | 18.5 | 10.3 | 16.0 | 9.1 | 15.5 | 10.0 | 11.3 | 10.6 | 7.9 | 11.7 |
| 6 m | 8.3 | 10.4 | 9.3 | 13.0 | 18.5 | 10.2 | 16.0 | 9.1 | 15.5 | 10.0 | 11.3 | 10.6 | 7.9 | 11.7 |
| 7 m | 8.3 | 10.4 | 9.0 | 13.2 | 18.5 | 10.3 | 16.0 | 9.2 | 15.5 | 10.0 | 11.3 | 10.6 | 7.9 | 11.7 |
| 8 m | 8.3 | 10.5 | 9.0 | 13.2 | 18.5 | 10.3 | 16.0 | 9.2 | 15.5 | 10.0 | 11.3 | 10.5 | 7.9 | 11.8 |
| 9 m | 8.0 | 10.5 | 8.8 | 13.2 | 18.5 | 10.4 | 16.0 | 9.2 | 15.5 | 10.0 | 11.3 | 10.5 | 7.9 | 11.8 |
| 10 m | 8.0 | 10.5 | 8.8 | 13.3 | 18.5 | 10.4 | 16.0 | 9.2 | 15.5 | 10.0 | 11.3 | 10.6 | 7.9 | 11.8 |
| 11 m | 8.0 | 10.5 | 8.0 | 13.3 | 18.3 | 10.4 | 15.5 | 9.2 | 15.0 | 10.1 | 11.3 | 10.6 | 7.9 | 11.8 |
| 12 m | 8.0 | 10.5 | 7.8 | 13.5 | 18.0 | 10.4 | 13.7 | 9.4 | 15.0 | 10.1 | 11.3 | 10.6 | 7.9 | 11.8 |
| Mean | 8.2 | 10.4 | 9.2 | 13.1 | 18.6 | 10.3 | 15.9 | 9.1 | 15.5 | 10.0 | 11.3 | 10.6 | 7.9 | 11.6 |
| Secchi | 1.6 m |  | 5.1 m |  | 3.4 m |  | 4.6 m |  | 5.1 m |  | 6.0 m |  | - |  |

# APPENDIX G

## DISSOLVED OXYGEN & TEMPERATURE PROFILES AT SPAR 107

## BRUCE GS 'B' 1979

Temp = °C

DO = ppm

| Depth | May 18 | | June 7 | | July 24 | | August 23 | | September 27 | | October 31 | | November 21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temp | DO | Temp | DO | Temp | DO | Temp | DO | Temp | DO | Temp | DO | Temp | DO |
| Surface | 9.0 | 10.3 | 10.0 | 13.0 | 18.0 | 10.0 | 16.1 | 8.9 | 16.0 | 9.9 | 10.7 | 11.2 | 8.0 | 11.0 |
| 1 m | 8.8 | 10.3 | 10.0 | 13.0 | 18.0 | 10.0 | 16.0 | 8.8 | 15.5 | 9.9 | 11.0 | 11.0 | 8.0 | 11.4 |
| 2 m | 8.8 | 10.3 | 10.0 | 13.0 | 18.5 | 10.2 | 16.0 | 8.9 | 15.5 | 9.9 | 11.0 | 11.0 | 8.0 | 11.6 |
| 3 m | 8.5 | 10.3 | 10.0 | 13.0 | 18.5 | 10.2 | 16.0 | 8.9 | 15.5 | 10.0 | 11.0 | 10.8 | 8.0 | 11.6 |
| 4 m | 8.5 | 10.3 | 9.5 | 13.1 | 18.5 | 10.2 | 16.0 | 8.9 | 15.5 | 10.0 | 11.0 | 10.8 | 8.0 | 11.6 |
| 5 m | 8.5 | 10.3 | 9.5 | 13.1 | 18.5 | 10.3 | 16.0 | 9.0 | 15.5 | 10.0 | 11.0 | 10.8 | 7.9 | 11.6 |
| 6 m | 8.5 | 10.3 | 9.0 | 13.1 | 18.5 | 10.3 | 16.0 | 9.0 | 15.5 | 10.0 | 11.0 | 10.8 | 7.9 | 11.6 |
| 7 m | 8.5 | 10.3 | 9.0 | 13.1 | 18.5 | 10.3 | 16.0 | 9.0 | 15.5 | 10.0 | 11.0 | 10.8 | 7.9 | 11.7 |
| 8 m | 8.5 | 10.3 | 9.0 | 13.3 | 18.5 | 10.3 | 16.0 | 9.0 | 15.5 | 10.0 | 11.0 | 10.8 | 7.8 | 11.7 |
| 9 m | 8.5 | 10.3 | 8.8 | 13.3 | 18.5 | 10.3 | 16.0 | 9.1 | 15.5 | 10.0 | 11.0 | 10.8 | 7.8 | 11.6 |
| 10 m | 8.5 | 10.3 | 8.5 | 13.4 | 18.5 | 10.3 | 16.0 | 9.1 | 15.0 | 10.2 | 11.0 | 10.8 | 7.8 | 11.7 |
| 11 m | 8.5 | 10.4 | 8.5 | 13.8 | 18.5 | 10.3 | 16.0 | 9.1 | 15.0 | 10.2 | 11.0 | 10.8 | 7.8 | 11.7 |
| 12 m | 8.5 | 10.4 | 8.0 | 14.0 | 18.5 | 10.3 | 15.0 | 9.2 | 15.0 | 10.2 | 10.7 | 10.8 | 7.8 | 11.7 |
| Mean | 8.6 | 10.3 | 9.2 | 13.3 | 18.4 | 10.2 | 15.9 | 9.0 | 15.4 | 10.0 | 11.0 | 10.9 | 7.9 | 11.6 |
| Secchi | 1.6 m | | 4.9 m | | 3.4 m | | 5.0 m | | 5.2 m | | 6.0 m | | - | |

## APPENDIX H

## TEMPERATURE PROFILES AT HYDRAULIC STUDIES DEPARTMENT LOCATIONS

## BRUCE GS 'B' 1979

THB04

| Depth (m) \ Temperature (°C) | May 2 | May 22 | June 19 | July 9 | July 31 | Sept 6 | Sept 25 | Oct 19 | Nov 6 |
|---|---|---|---|---|---|---|---|---|---|
| 0.5 | 1.6 | | 10.0 | 14.2 | | | | 12.3 | |
| 1.0 | | | | 14.1 | | | | 12.4 | |
| 2.0 | 1.7 | 10.1 | 10.0 | 14.0 | 19.9 | 20.1 | | | 9.8 |
| 3.0 | | | 10.0 | 14.2 | | 20.1 | 13.8 | | |
| 4.0 | 1.7 | 10.0 | 9.8 | 13.6 | 19.9 | 19.5 | | 12.4 | |
| 5.0 | 1.6 | | 9.6 | 12.0 | 19.8 | 19.2 | | | |
| 6.0 | | 10.0 | 9.0 | 11.8 | 19.7 | 19.1 | 13.8 | | 9.5 |
| 7.0 | 1.7 | 9.9 | 8.1 | 11.3 | 19.4 | 18.7 | 13.9 | | |
| 8.0 | 2.1 | 9.7 | 6.9 | 11.1 | 19.3 | 18.5 | | 12.4 | |
| 8.5 | | | | | | 17.2 | | | |
| 9.0 | 2.5 | 9.0 | 6.8 | 11.0 | 19.2 | 15.8 | | | |
| 9.5 | | | | | | 14.2 | | | |
| 10.0 | 2.8 | 8.0 | 6.5 | 10.8 | | 13.8 | 13.9 | | 9.5 |
| 10.5 | | | | | | 13.2 | | | |
| 11.0 | | 7.0 | 6.5 | 10.1 | 19.1 | 12.4 | | | |
| 11.5 | | | | | | 12.1 | | | |
| 12.0 | | 6.4 | 6.3 | 9.7 | 19.0 | 12.1 | | 12.4 | |
| 12.5 | | | | | | 11.5 | | | |
| 13.0 | 2.8 | 5.9 | 6.2 | 9.2 | | 10.9 | 13.9 | 12.3 | 9.5 |
| 14.0 | | 3.4 | 6.2 | 9.0 | 18.9 | 10.4 | 14.0 | 12.2 | 1.4 |
| 15.0 | | 4.8 | 6.0 | 8.6 | 18.8 | 8.9 | | | |
| 16.0 | 2.8 | 4.2 | 5.8 | 8.4 | 11.8 | 8.2 | | | |
| 17.0 | 2.9 | 4.2 | 5.6 | 8.4 | 10.0 | 7.8 | 14.0 | 12.2 | |
| 18.0 | | 4.2 | 5.5 | 8.3 | 8.8 | 7.2 | | | |
| 19.0 | | 4.1 | 5.2 | 8.3 | 8.3 | 6.8 | | | |
| 20.0 | 2.9 | 4.1 | 5.1 | 8.0 | 8.1 | 6.8 | 14.0 | 12.2 | |
| | | | | | | | | | |

# APPENDIX H

## TEMPERATURE PROFILES AT HYDRAULIC STUDIES DEPARTMENT LOCATIONS

### BRUCE GS 'B' - 1979

CMB05

| Depth | May 2 | May 22 | June 18 | July 9 | July 31 | Sept 6 | Sept 24 | Oct 16 | Nov 6 |
|---|---|---|---|---|---|---|---|---|---|
| 0.5 | 1.7 |  | 9.4 | 14.4 | 20.0 | 20.1 |  | 12.7 |  |
| 1.0 | 1.8 |  | 8.8 | 13.9 |  | 20.2 |  | 12.7 | 9.4 |
| 2.0 |  |  | 8.8 | 13.8 |  | 20.6 | 13.4 | 12.8 | 9.5 |
| 3.0 | 1.7 | 10.1 | 8.7 | 13.8 | 20.0 | 20.7 | 13.3 | 12.8 |  |
| 4.0 |  | 9.9 | 8.5 | 13.2 | 19.9 | 20.0 |  | 12.7 |  |
| 5.0 | 1.7 | 9.4 | 8.3 | 13.0 |  | 19.9 | 13.3 |  |  |
| 6.0 | 2.0 | 9.2 | 8.1 | 12.8 | 19.9 | 19.8 | 13.5 | 12.7 | 9.5 |
| 7.0 | 2.2 | 8.8 | 7.8 | 12.4 | 19.7 | 19.2 | 13.7 | 12.6 |  |
| 8.0 | 2.6 | 8.2 | 7.7 | 12.2 | 19.7 | 18.5 | 13.6 | 12.5 |  |
| 8.5 |  |  |  |  |  | 17.0 |  |  |  |
| 9.0 | 2.8 | 7.5 | 7.2 | 11.8 | 19.5 | 15.1 | 13.6 |  |  |
| 10.0 | 2.9 | 6.8 | 7.0 | 11.2 | 19.3 | 14.2 | 13.5 |  | 9.5 |
| 11.0 |  | 6.1 | 6.8 | 10.9 | 19.2 | 13.0 | 13.4 | 12.5 |  |
| 12.0 | 2.9 | 6.0 | 6.5 | 10.1 |  | 12.0 | 13.2 |  |  |
| 13.0 | 3.0 | 5.4 | 6.4 | 9.9 |  | 11.3 | 12.9 |  | 9.5 |
| 14.0 | 3.0 | 5.2 | 6.4 | 8.8 | 19.2 | 10.9 | 12.9 | 12.5 | 9.4 |

## APPENDIX H

## TEMPERATURE PROFILES AT HYDRAULIC STUDIES DEPARTMENT LOCATIONS

### BRUCE GS 'B' - 1979

THB08

| Temperature / Depth (m) | May 2 | May 23 | June 19 | July 9 | July 31 | Sept 6 | Sept 24 | Oct 16 | Nov 5 |
|---|---|---|---|---|---|---|---|---|---|
| 0.5 |  | 10.3 | 6.3 | 14.2 |  |  |  | 12.9 |  |
| 1.0 | 4.2 | 10.0 | 6.3 | 14.0 | 20.1 | 20.1 | 13.9 | 12.8 | 9.2 |
| 1.5 |  | 10.3 |  | 13.8 |  |  |  |  |  |
| 2.0 | 3.9 | 9.9 | 6.3 | 14.0 |  | 20.1 | 13.8 |  |  |
| 2.5 | 3.9 | 9.8 | 6.2 | 13.9 | 20.1 | 19.9 | 13.4 | 12.8 | 9.2 |
|  |  |  |  |  |  |  |  |  |  |

# APPENDIX K

## ATTACHED ALGAE DRY AND ASH WEIGHT (gm/m$^2$ ± 1 SD)

## BRUCE GS 'B' - 1979

| Location | Depth | | June 7 | August 9 | October 4 |
|---|---|---|---|---|---|
| Douglas Point | S | D | 121 ± 29 | 54 ± 27 | 182 ± 155 |
| | | A | 35 ± 17 | 11 ± 5 | 7 ± 3 |
| | 3 M | D | 46 ± 14 | 16 ± 11 | 319 ± 164 |
| | | A | 9 ± 2 | 4 ± 2 | 13 ± 3 |
| Lagoon Bay | S | D | 140.± 24 | NA | 339 ± 143 |
| | | A | 42 ± 32 | NA | 21 ± 8 |
| | 3 M | D | 63 ± 8 | 6 ± 2 | 157 ± 41 |
| | | A | 11 ± 2 | 2 ± 2 | 13 ± 2 |
| Bruce 'B' discharge | S | D | 7 ± 3 | NA | 6 ± 2 |
| | | A | 2 ± 1 | NA | 3 ± <1 |
| | 3 M | D | 104 ±107 | 36 ± 2 | 368 ± 79 |
| | | A | 5 ± 4 | 4 ± 1 | 21 ± 3 |
| Bruce 'B' intake | S | D | 578 ±.69 | NA | 668 ± 254 |
| | | A | 51 ± 7 | NA | 49 ± 38 |
| | 3 M | D | 57 ± 12 | 127 ± 101 | 136 ± 85 |
| | | A | 7 ± 1 | 8 ± 1 | 10 ± 3 |
| South Boundary | S | D | 239 ± 37 | NA | 108 ± 46 |
| | | A | 43 ± 12 | NA | 18 ± 5 |
| | 3 M | D | 30 ± 11 | 23 ± 10 | 3.± 1.5 |
| | | A | 5 ± 1 | 4 ± 2 | 3 ± 2 |
| Holmes Bay | S | D | 16 ± 13 | NA | 86 ± 47 |
| | | A | 2 ± 3 | NA | 11 ± 8 |
| | 3 M | D | 560 ±324 | 12 ± 6 | 87 ± 54 |
| | | A | 11 ± 7 | 4 ± 2 | 8 ± 4 |
| Gunn Point | S | D | 145 ± 35 | 11 ± 11 | 6 ± 4.5 |
| | | A | 23 ± 2 | 9 ± 12 | 2 ± 1 |
| | 3 M | D | 541 ±758 | 14 ± 14 | 2.6± 3.5 |
| | | A | 1 ± <1 | 2 ± 2 | <1 ± <1 |

S - shoreline
D - dry weight
A - ash free dry weight
NA - No attached algae

## APPENDIX M

### SPECIES LIST OF FISH CAPTURED BY ALL GEAR TYPES IN THE VICINITY OF BRUCE GS B DURING 1979

| Common Name | Scientific Name |
|---|---|
| Herring | Clupeidae |
| Alewife | Alosa pseudoharengus |
| Gizzard Shad | Dorosoma cepedianum |
| Salmons, Trouts and Whitefishes | Salmonidae |
| Brown Trout | Salmo trutta |
| Chinook Salmon | Oncorhynchus tshawytscha |
| Cisco | Coregonus artedii |
| Coho Salmon | Oncorhynchus kisutch |
| Rainbow Trout | Salmo gairdneri |
| Round Whitefish | Prosopium cylindraceum |
| Splake | Salvelinusnamaycush/ fontinali |
| Smelts | Osmeridae |
| Rainbow Smelt | Osmerus mordax |
| Pikes | Esocidae |
| Northern Pike | Esox lucius |
| Minnows | Cyprinidae |
| Bluntnose Minnow | Pimephales notatus |
| Carp | Cyprinus carpio |
| Common Shiner | Notropis cornutus |
| Emerald Shiner | Notropis atherinoides |
| Lake Chub | Couesius plumbeus |
| Longnose Dace | Rhinichthys cataractae |
| Spottail Shiner | Notropis hudsonius |
| Suckers | Catostomidae |
| Longnose Sucker | Catostomus catostomus |
| Redhorse Sucker | Moxostoma sp. |
| White Sucker | Catostomus commersoni |
| Catfishes | Ictaluridae |
| Channel Catfish | Ictalurus punctatus |
| Stonecat | Noturus flavus |
| Cods | Gadidae |
| Burbot | Lota lota |
| Sticklebacks | Gasterosteidae |
| Ninespine Stickleback | Pungitius pungitius |
| Trout-perches | Percopsidae |
| Trout-perch | Percopsis omiscomaycus |
| Temperate Basses | Percichthyidae |
| White Bass | Morone chrysops |
| Sunfishes | Centrarchidae |
| Pumpkinseed | Lepomis gibbosus |
| Rock Bass | Ambloplites rupestris |
| Smallmouth Bass | Micropterus dolomieui |
| Perches | Percidae |
| Johnny Darter | Etheostoma nigrum |
| Logperch | Percina caprodes |
| Walleye | Stizostedion vitreum |
| Yellow Perch | Perca flavescens |
| Drums | Sciaenidae |
| Freshwater Drum | Aplodinotus grunniens |
| Sculpins | Cottidae |
| Deepwater Sculpin | Myoxocephalus quadricornis |
| Slimy Sculpin | Cottus cognatus |

# APPENDIX B

## SUMMARIES OF VERTICAL DISTRIBUTION OF FISH - BRUCE G.S. 'B' - 1979
## (NUMBER PER 10,000 M³)

(I) DAY

JUNE 6

| Depth* Shell | Bottom Depth Range | 3-9 | 11-15 | 17-21 | 23-27 | 29-33 | 35-50 |
|---|---|---|---|---|---|---|---|
| | No. of Intervals | 11 | 12 | 19 | 29 | 30 | 11 |
| 3-9 | Mean Density | [illegible] | 0.0 | 0.0 | 5.31 | 5.33 | 4.92 |
| | St Dev | 315.86 | 0.0 | 0.0 | 13.10 | 18.95 | 12.02 |
| 9-15 | | | 107.92 | 0.0 | 0.0 | 1.10 | 0.0 |
| | | | 31.01 | 0.0 | 0.0 | 6.03 | 0.0 |
| 15-21 | | | | 66.61 | 0.0 | 0.0 | 0.0 |
| | | | | 90.15 | 0.0 | 0.0 | 0.0 |
| 21-27 | | | | | [illegible] | 0.0 | 0.0 |
| | | | | | 23.12 | 0.0 | 0.0 |
| 27-33 | | | | | | 18.41 | 0.0 |
| | | | | | | 15.94 | 0.0 |
| 33-50 | | | | | | | 0.0 |
| | | | | | | | 0.0 |

AUGUST 30

| Depth* Shell | Bottom Depth Range | 3-9 | 11-15 | 17-21 | 23-27 | 29-33 | 35-50 |
|---|---|---|---|---|---|---|---|
| | No. of Intervals | 12 | 16 | 21 | 28 | 31 | 1 |
| 3-9 | Mean Density | 401.92 | 12.06 | 7.67 | 5.71 | 4.43 | 0.0 |
| | St Dev | 530.08 | 33.03 | 13.97 | 12.48 | 10.90 | 0.0 |
| 9-15 | | | 150.36 | 16.67 | 5.04 | 0.81 | 0.0 |
| | | | 117.40 | 76.38 | 13.11 | 4.49 | 0.0 |
| 15-21 | | | | 87.48 | 1.07 | 1.10 | 0.0 |
| | | | | 92.78 | 5.67 | 0.54 | 0.0 |
| 21-27 | | | | | 65.07 | 1.65 | 0.0 |
| | | | | | 16.92 | 19.57 | |
| 27-33 | | | | | | 43.39 | |
| | | | | | | 32.79 | 0.0 |
| 33-50 | | | | | | | 0.0 |
| | | | | | | | 0.0 |

OCTOBER 30

| Depth* Shell | Bottom Depth Range | 3-9 | 11-15 | 17-21 | 23-27 | 29-33 | 35-50 |
|---|---|---|---|---|---|---|---|
| | No. of Intervals | 5 | 18 | 22 | 28 | 32 | 7 |
| 3-9 | Mean Density | 611.11 | 0.0 | 1.45 | 0.0 | 1.00 | 0.0 |
| | St Dev | 596.92 | 0.0 | 6.92 | 0.0 | 5.66 | 0.0 |
| 9-15 | | | 200.67 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | 146.91 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15-21 | | | | 90.59 | 0.25 | 0.0 | 0.0 |
| | | | | 65.59 | 1.32 | 0.0 | 0.0 |
| 21-27 | | | | | 59.61 | 0.25 | 0.0 |
| | | | | | 30.22 | 1.41 | 0.0 |
| 27-33 | | | | | | 21.31 | 7.29 |
| | | | | | | 16.90 | 19.28 |
| 33-50 | | | | | | | 0.0 |
| | | | | | | | 0.0 |

ONLY BLOCKED DATA REPRESENTS INTERVALS CONTAINING THE BOTTOM
*DEPTH BELOW TRANSDUCER; ADD 1 m FOR ACTUAL DEPTH

(II) NIGHT

JUNE 6

| Depth Shell | Bottom Depth Range | 3-9 | 11-15 | 17-21 | 23-27 | 29-33 | 35-50 |
|---|---|---|---|---|---|---|---|
| | No. of Intervals | [illegible] | 13 | 18 | [illegible] | 28 | 12 |
| 3-9 | Mean Density | 411.31 | 61.37 | 78.36 | 21.00 | 17.21 | 26.67 |
| | St Dev | [illegible] | 76.06 | [illegible] | [illegible] | 40.96 | [illegible] |
| 9-15 | | | 131.09 | 5.30 | [illegible] | [illegible] | 0.0 |
| | | | [illegible] | 10.37 | [illegible] | 1.41 | 0.0 |
| 15-21 | | | | [illegible] | 1.10 | 1.21 | [illegible] |
| | | | | [illegible] | [illegible] | 1.15 | [illegible] |
| 21-27 | | | | | [illegible] | 1.40 | [illegible] |
| | | | | | 40.80 | [illegible] | [illegible] |
| 27-33 | | | | | | [illegible] | [illegible] |
| | | | | | | [illegible] | [illegible] |
| 33-50 | | | | | | | [illegible] |
| | | | | | | | [illegible] |

OCTOBER 30

| Depth Shell | Bottom Depth Range | 3-9 | 11-15 | 17-21 | 23-27 | 29-33 | 35-50 |
|---|---|---|---|---|---|---|---|
| | No. of Intervals | 12 | [illegible] | 16 | 30 | [illegible] | 18 |
| 3-9 | Mean Density | [illegible] | [illegible] | 2.00 | 0.0 | 18.06 | [illegible] |
| | St Dev | [illegible] | 11.62 | 8.00 | 0.0 | [illegible] | [illegible] |
| 9-15 | | | [illegible] | 1.06 | [illegible] | 1.00 | 4.00 |
| | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 15-21 | | | | [illegible] | 0.0 | [illegible] | [illegible] |
| | | | | [illegible] | 0.0 | 0.66 | [illegible] |
| 21-27 | | | | | [illegible] | [illegible] | [illegible] |
| | | | | | [illegible] | [illegible] | [illegible] |
| 27-33 | | | | | | [illegible] | [illegible] |
| | | | | | | [illegible] | [illegible] |
| 33-50 | | | | | | | [illegible] |
| | | | | | | | [illegible] |

## APPENDIX 5

## GILL NET CATCHES - BRUCE GS 'B' - ACOUSTIC CENSUS - 1979

| Species and Size Range (cm) | June 5-6/79 | | | | | | August 30/79 | | | | | | October 30/79 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day | | | Night | | | Day | | | Night | | | Day | | | Night | | |
| | TS | IB | OB | IS | IB | OB | TS | IB | OB | TS | IB | OB | TS | IB | OB | IS | IB | OB |
| Alewife | | | | | | | | | | | | | | | | | | |
| 6.9 - 12.[illegible] | 1 | | | 20 | 5 | 1 | | | | 25 | | | | | | | | |
| 14.0 - 16.9 | | | 1 | 165 | 14 | | | | | 5 | | 2 | | | | | | |
| Total | 1 | | 1 | 185 | 19 | 1 | | | | 30 | | 2 | | | | | | |
| Lake Cisco | | | | | | | | | | | | | | | | | | |
| 9.7 - 17.[illegible] | 5 | | | | 18 | | | | | | 1 | | | | | | 2 | |
| Longnose Sucker | | | | | | | | | | | | | | | | | | |
| [illegible] - 21.[illegible] | | | | | 1 | | | | | | 1 | | | | | | | 1 |
| 26.[illegible] - 45.[illegible] | | | | | 15 | | | | | | 5 | | | | 1 | | 1 | |
| Total | | | | | 16 | | | | | | 6 | | | | 1 | | 1 | 1 |
| White Sucker | | | | | | | | | | | | | | | | | | |
| 14.[illegible] - 42.[illegible] | | | | | 1 | | | | | | 9 | | | | | | 1 | |
| Round Whitefish | | | | | | | | | | | | | | | | | | |
| 16.[illegible] - 41.9 | | 1 | | 1 | | | | | | | 2 | 1 | | | | | 1 | |
| Smelt | | | | | | | | | | | | | | | | | | |
| 21.[illegible] - [illegible] | | | | 1 | 2 | | | | | | | 1 | | | | | 1 | |
| Yellow Perch | | | | | | | | | | | | | | | | | | |
| 21.4 - 26.[illegible] | | | | | 2 | | | | | | 1 | | | | | | | |
| Burbot | | | | | | | | | | | | | | | | | | |
| [illegible] - [illegible] | | | | | | 1 | | | | | | | | | | | | 1 |
| Spottail Shiner | | | | | | | | | | | | | | | | | | |
| [illegible] - [illegible] | 2 | | | | | | | | | 1 | 1 | | | | | | | |
| Common Shiner | | | | | | | | | | | | | | | | | | |
| 9.7 | | | | | | | | | | 1 | | | | | | | | |
| Lake Herring | | | | | | | | | | | | | | | | | | |
| 17.[illegible] | | | | | | | | | | | | 1 | | | | | | |

IS - Inshore surface
IB - Inshore bottom
OB - Offshore bottom

# APPENDIX T

## SIZE DISTRIBUTION OF MAJOR SPECIES CAPTURED AT BRUCE 'B' GS, 1979, DURING ACOUSTIC FISH CENSUS SURVEYS

(SIZE CLASS - cm)

| Species | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 21 | 24 | 26 | 29 | 30 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | 2 | 15 | 26 | 9 |  | 5 | 15 | 19 | 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Lake Club |  | 5 | 8 | 3 | 4 | 3 | 2 | 4 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Longnose Sucker |  |  |  |  |  |  |  | 1 | 1 |  | 1 |  | 1 | 1 |  | 2 | 1 | 1 | 1 |  | 3 | 1 | 3 | 4 |  | 1 | 2 | 2 |
| White Sucker |  |  |  |  |  |  |  |  |  |  |  | 1 |  |  | 1 |  | 1 | 1 | 2 | 1 | 4 | 1 |  |  | 1 | 1 |  |  |
| Round Whitefish |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 1 | 2 | 3 |  | 2 | 1 |  |  |  |

# APPENDIX U

## HORIZONTAL TEMPERATURE DISTRIBUTION AT 0.5 m
## BRUCE GS 'B' ACOUSTIC CENSUS - 1979

### NIGHT

| Date | Distance from 5 m Depth (m) | Transect | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| June 6 | 0 | 9.9 | 9.0 | 9.2 | 9.5 | 8.8 | 8.5 | 9.0 |
| | 200 | 9.7 | 9.5 | 8.7 | 9.0 | 8.7 | 8.5 | 9.0 |
| | 400 | 9.7 | 9.4 | 8.5 | 8.3 | 9.0 | 8.5 | 9.3 |
| | 600 | 9.5 | 9.2 | 8.5 | 8.4 | 9.2 | 8.6 | 9.5 |
| | 800 | 9.2 | 8.7 | 8.6 | 8.5 | 9.3 | 9.1 | 9.5 |
| | 1000 | 8.8 | 8.7 | 8.6 | 8.5 | 9.4 | 9.5 | 9.6 |
| | 1200 | 8.8 | 9.0 | 8.6 | 8.8 | 9.5 | 9.8 | 9.6 |
| | 1400 | 9.0 | 8.8 | 8.7 | 9.2 | 9.5 | 9.7 | 9.4 |
| | 1600 | 9.0 | 9.0 | 9.0 | 9.5 | 9.5 | 9.5 | 9.4 |
| | 1800 | 9.2 | 9.2 | 9.2 | 9.5 | 9.5 | 9.5 | 9.4 |
| | 2000 | 9.5 | 9.3 | 9.5 | 9.5 | 9.5 | 9.5 | 9.6 |
| October 30 | 0 | 9.9 | 10.0 | 10.0 | 10.0 | 10.0 | 10.1 | 10.1 |
| | 200 | 10.0 | 10.0 | 10.1 | 10.0 | 10.0 | 10.1 | 10.0 |
| | 400 | 10.0 | 10.0 | 10.1 | 10.1 | 10.1 | 10.2 | 10.1 |
| | 600 | 10.0 | 10.0 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 |
| | 800 | 10.0 | 10.0 | 10.2 | 10.2 | 10.2 | 10.3 | 10.2 |
| | 1000 | 10.0 | 10.0 | 10.2 | 10.2 | 10.2 | 10.3 | 10.2 |
| | 1200 | 10.0 | 10.0 | 10.1 | 10.2 | 10.1 | 10.3 | 10.2 |
| | 1400 | 9.9 | 10.0 | 10.0 | 10.1 | 10.1 | 10.2 | 10.2 |
| | 1600 | 9.9 | 9.9 | 10.0 | 10.1 | 10.1 | 10.2 | 10.1 |
| | 1800 | 9.8 | 9.8 | 10.0 | 10.0 | 10.0 | 10.2 | 10.1 |
| | 2000 | 9.8 | 9.8 | 10.0 | 10.0 | 10.0 | 10.2 | 10.1 |

# APPENDIX U

## HORIZONTAL TEMPERATURE DISTRIBUTION AT 0.5 M
## BRUCE GS 'B' ACOUSTIC CENSUS - 1979

### DAY

| Date | Distance from 5 m Depth (m) | Transect | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| June 6 | 0 | 12.0 | 12.0 | 11.0 | 11.0 | 10.8 | 10.6 | 10.2 |
| | 200 | 12.2 | 12.0 | 11.3 | 11.0 | 10.6 | 10.3 | 10.5 |
| | 400 | 10.5 | 11.5 | 11.6 | 11.0 | 10.3 | 10.4 | 10.2 |
| | 600 | 10.5 | 10.4 | 10.5 | 10.6 | 10.3 | 10.5 | 10.3 |
| | 800 | 10.4 | 10.3 | 10.4 | 10.5 | 10.3 | 10.5 | 10.3 |
| | 1000 | 10.3 | 10.3 | 10.4 | 10.5 | 10.3 | 10.5 | 10.4 |
| | 1200 | 10.3 | 10.3 | 10.4 | 10.5 | 10.5 | 10.5 | 10.5 |
| | 1400 | 10.3 | 10.3 | 10.4 | 10.5 | 10.5 | 10.5 | 10.5 |
| | 1600 | 10.3 | 10.3 | 10.4 | 10.5 | 10.5 | 10.4 | 10.4 |
| | 1800 | 10.3 | 10.3 | 10.4 | 10.4 | 10.4 | 10.4 | 10.4 |
| | 2000 | 10.2 | 10.2 | 10.3 | 10.2 | 10.3 | 10.3 | 10.4 |
| August 30 | 0 | 19.7 | 19.9 | 19.7 | 19.9 | 19.8 | | 19.8 |
| | 200 | 19.8 | 19.8 | 19.8 | 19.7 | 19.8 | 19.8 | 19.9 |
| | 400 | 19.6 | 19.7 | 19.9 | 19.6 | 19.7 | 19.8 | 19.8 |
| | 600 | 19.5 | 19.6 | 19.9 | 19.5 | 19.7 | 19.7 | 19.7 |
| | 800 | 19.4 | 19.5 | 19.8 | 19.4 | 19.7 | 19.7 | 19.6 |
| | 1000 | 19.3 | 19.4 | 19.7 | 19.3 | 19.5 | 19.5 | 19.4 |
| | 1200 | 19.2 | 19.3 | 19.5 | 19.3 | 19.3 | 19.4 | 19.2 |
| | 1400 | 19.1 | 19.2 | 19.3 | 19.2 | 19.0 | 19.3 | 19.0 |
| | 1600 | 19.1 | 19.1 | 19.2 | 18.7 | 18.8 | 19.0 | 19.0 |
| | 1800 | 19.0 | 19.0 | 19.1 | 18.5 | 18.7 | 18.7 | 18.9 |
| | 2000 | 19.0 | 18.9 | 19.0 | 18.0 | 18.6 | 18.6 | 18.9 |
| October 30 | 0 | 10.3 | 10.3 | 10.3 | 10.2 | 10.0 | 10.0 | 10.0 |
| | 200 | 10.3 | 10.3 | 10.3 | 10.2 | 10.0 | 10.0 | 10.0 |
| | 400 | 10.3 | 10.3 | 10.3 | 10.2 | 10.1 | 10.1 | 10.1 |
| | 600 | 10.3 | 10.3 | 10.3 | 10.2 | 10.2 | 10.1 | 10.1 |
| | 800 | 10.3 | 10.3 | 10.3 | 10.2 | 10.2 | 10.2 | 10.2 |
| | 1000 | 10.3 | 10.3 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 |
| | 1200 | 10.3 | 10.3 | 10.3 | 10.2 | 10.2 | 10.2 | 10.2 |
| | 1400 | 10.3 | 10.3 | 10.3 | 10.2 | 10.1 | 10.2 | 10.2 |
| | 1600 | 10.3 | 10.3 | 10.3 | 10.2 | 10.1 | 10.1 | 10.2 |
| | 1800 | 10.3 | 10.3 | 10.3 | 10.2 | 10.1 | 10.1 | 10.1 |
| | 2000 | 10.3 | 10.3 | 10.3 | 10.2 | 10.1 | 10.1 | 10.1 |

# APPENDIX V

## TEMPERATURE PROFILES
## BRUCE GS 'B' ACOUSTIC CENSUS - 1979

| Date | Depth (m) | Distance from 5 m Contour | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 200 | 400 | 600 | 800 | 1000 | 12[illegible] | 1400 | 1600 | 1800 | 2000 |
| June 6 | Surface | 10.8 | 10.6 | 10.8 | 10.8 | 10.9 | 10.8 | 10.8 | 10.8 | 10.8 | 10.4 | 10.5 |
| | 1 | 10.5 | 10.6 | 10.5 | 10.7 | 10.8 | 10.7 | 10.8 | 10.6 | 10.7 | 10.4 | 10.4 |
| | 2 | 10.2 | 10.5 | 10.5 | 10.7 | 10.8 | 10.6 | 10.7 | 10.5 | 10.5 | 10.0 | 10.1 |
| | 3 | 10.0 | 9.9 | 9.8 | 10.0 | 10.4 | 10.0 | 10.1 | 9.5 | 9.6 | 9.4 | 8.4 |
| | 4 | 9.5 | 9.5 | 9.5 | 9.8 | 9.8 | 9.7 | 9.5 | 9.2 | 9.2 | 8.7 | 8.3 |
| | 5 | 9.0 | 9.4 | 9.5 | 9.5 | 9.6 | 9.6 | 9.4 | 9.0 | 8.9 | 8.3 | 8.0 |
| | 6 | 8.8 | 9.3 | 9.3 | 9.5 | 9.5 | 9.4 | 9.3 | 8.8 | 8.8 | 8.1 | 7.8 |
| | 7 | 9.0 | 9.0 | 9.2 | 9.0 | 9.3 | 9.0 | 9.1 | 8.0 | 7.8 | 7.5 | 7.4 |
| | 8 | | 8.5 | 9.0 | 8.5 | 8.9 | 8.7 | 8.8 | 7.2 | 7.5 | 6.7 | 6.6 |
| | 9 | | | 8.5 | 8.4 | 8.5 | 7.7 | 8.5 | 7.0 | 7.0 | 6.5 | 6.2 |
| | 10 | | | 8.4 | 8.1 | 7.8 | 7.5 | 7.5 | 6.7 | 6.7 | 6.2 | 6.0 |
| | 11 | | | 8.2 | 7.7 | 7.5 | 7.3 | 7.0 | 6.7 | 6.6 | 6.1 | 6.0 |
| | 12 | | | 8.0 | 7.5 | 7.5 | 7.2 | 6.9 | 6.6 | 6.5 | 6.1 | 5.9 |
| | 13 | | | 7.5 | 7.5 | 7.4 | 7.1 | 6.7 | 6.5 | 6.5 | 6.0 | 5.8 |
| | 14 | | | 7.4 | 7.4 | 7.3 | 6.9 | 6.5 | 6.3 | 6.3 | 6.0 | 5.6 |
| | 15 | | | | 7.2 | 7.2 | 6.7 | 6.3 | 6.2 | 6.1 | 5.9 | 5.5 |
| | 16 | | | | 7.1 | 7.1 | 6.6 | 6.2 | 6.1 | 6.0 | 5.7 | 5.5 |
| | 17 | | | | 7.0 | 7.0 | 6.5 | 6.2 | 6.0 | 6.0 | 5.5 | 5.4 |
| | 18 | | | | 6.8 | 6.7 | 6.3 | 6.2 | 5.9 | 5.9 | 5.5 | 5.4 |
| | 19 | | | | 6.6 | 6.6 | 6.3 | 6.1 | 5.9 | 5.9 | 5.4 | 5.3 |
| | 20 | | | | 6.5 | 6.5 | 6.2 | 6.1 | 5.8 | 5.8 | 5.4 | 5.3 |
| | 21 | | | | | 6.3 | 6.1 | 6.0 | 5.7 | 5.7 | 5.3 | 5.3 |
| | 22 | | | | | 6.2 | 6.1 | 5.9 | 5.7 | 5.6 | 5.3 | 5.2 |
| | 23 | | | | | 6.0 | 6.0 | 5.8 | 5.6 | 5.5 | 5.2 | 5.2 |
| | 24 | | | | | | 5.7 | 5.6 | 5.5 | 5.3 | 5.1 | 5.0 |
| | 25 | | | | | | 5.5 | 5.5 | 5.5 | 5.0 | 5.0 | 4.9 |
| | 26 | | | | | | 5.4 | 5.0 | 5.2 | 4.8 | 4.8 | 4.7 |
| | 27 | | | | | | | 5.0 | 5.0 | 4.8 | 4.8 | 4.7 |
| | 28 | | | | | | | 5.0 | 4.9 | 4.7 | 4.7 | 4.6 |
| | 29 | | | | | | | 5.0 | 4.8 | 4.7 | 4.7 | 4.6 |
| | 30 | | | | | | | | | 4.5 | 4.4 | 4.5 |
| | 31 | | | | | | | | | 4.5 | 4.4 | 4.4 |
| | 32 | | | | | | | | | 4.5 | 4.4 | 4.4 |
| | 33 | | | | | | | | | 4.5 | 4.4 | 4.3 |
| | 34 | | | | | | | | | 4.5 | 4.4 | 4.0 |
| | 35 | | | | | | | | | | 4.4 | 4.0 |
| | 36 | | | | | | | | | | 4.4 | 4.0 |
| | 37 | | | | | | | | | | | 4.0 |
| August 30 | Surface | 18.5 | 18.2 | 18.2 | 18.1 | 18.0 | 18.0 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 1 | 18.3 | 18.2 | 18.1 | 18.0 | 18.0 | 18.0 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 2 | 18.3 | 18.1 | 18.0 | 18.0 | 18.0 | 18.0 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 3 | 18.3 | 18.1 | 18.0 | 18.0 | 18.0 | 18.0 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 4 | 18.3 | 18.1 | 18.0 | 18.0 | 18.0 | 18.0 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 5 | 18.3 | 18.1 | 18.0 | 18.0 | 18.0 | 17.9 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 6 | 18.3 | 18.1 | 18.0 | 18.0 | 18.0 | 17.9 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 7 | | 18.1 | 18.0 | 18.0 | 17.9 | 17.9 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 8 | | 18.1 | 18.0 | 18.0 | 17.9 | 17.9 | 17.7 | 17.7 | 17.6 | 17.5 | 17.5 |
| | 9 | | 18.1 | 18.0 | 17.9 | 17.8 | 17.9 | 17.7 | 17.7 | 17.5 | 17.5 | 17.5 |
| | 10 | | | 18.0 | 17.9 | 17.8 | 17.8 | 17.7 | 17.5 | 17.5 | 17.4 | 17.4 |
| | 11 | | | 18.0 | 17.8 | 17.7 | 17.6 | 17.5 | 17.5 | 17.5 | 17.4 | 17.4 |
| | 12 | | | 18.0 | 17.8 | 17.7 | 17.6 | 17.5 | 17.5 | 17.5 | 17.4 | 17.4 |
| | 13 | | | 18.0 | 17.8 | 17.6 | 17.5 | 17.5 | 17.5 | 17.5 | 17.4 | 17.4 |
| | 14 | | | 18.0 | 17.8 | 17.6 | 17.5 | 17.5 | 17.5 | 17.5 | 17.4 | 17.4 |
| | 15 | | | | 17.8 | 17.6 | 17.5 | 17.5 | 17.5 | 17.4 | 17.4 | 17.4 |
| | 16 | | | | 17.8 | 17.6 | 17.5 | 17.5 | 17.4 | 17.4 | 17.3 | 17.4 |
| | 17 | | | | 17.8 | 17.6 | 17.5 | 17.5 | 17.4 | 17.3 | 17.2 | 17.4 |
| | 18 | | | | 17.8 | 17.6 | 17.5 | 17.4 | 17.3 | 17.3 | 17.2 | 17.2 |
| | 19 | | | | 17.7 | 17.5 | 17.4 | 17.4 | 17.2 | 17.2 | 17.0 | 17.0 |
| | 20 | | | | | 17.5 | 17.4 | 17.3 | 16.9 | 17.0 | 16.7 | 16.8 |
| | 21 | | | | | | 17.4 | 17.1 | 16.5 | 16.7 | 16.3 | 16.4 |
| | 22 | | | | | | | 16.4 | 16.1 | 16.0 | 16.1 | 16.2 |
| | 23 | | | | | | | 15.8 | 15.9 | 15.4 | 15.7 | 16.2 |
| | 24 | | | | | | | 15.5 | 15.9 | 14.8 | 14.7 | 15.8 |
| | 25 | | | | | | | 15.4 | 15.5 | 14.4 | 14.0 | 15.0 |
| | 26 | | | | | | | | | 14.0 | 13.8 | 14.0 |
| | 27 | | | | | | | | | 12.5 | 13.0 | 13.0 |
| | 28 | | | | | | | | | 11.5 | 11.5 | 11.8 |
| | 29 | | | | | | | | | | 11.1 | 11.3 |
| | 30 | | | | | | | | | | 10.8 | 10.8 |
| | 31 | | | | | | | | | | 10.6 | 10.5 |
| | 32 | | | | | | | | | | | 10.1 |
| | 33 | | | | | | | | | | | 9.5 |
| | 34 | | | | | | | | | | | 8.0 |
| October 30 | Surface | 10.7 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 1 | 10.5 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 2 | 10.4 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 3 | 10.4 | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 4 | 10.4 | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 5 | 10.3 | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 6 | 10.3 | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 7 | 10.3 | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 8 | 10.3 | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 9 | | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | 10 | | | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.2 |
| | 11 | | | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.2 |
| | 12 | | | | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.2 | 10.2 |
| | 13 | | | | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.2 | 10.2 | 10.2 |
| | 14 | | | | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.2 | 10.2 | 10.2 |
| | 15 | | | | 10.1 | 10.3 | 10.3 | 10.2 | 10.2 | 10.1 | 10.1 | 10.1 |
| | 16 | | | | 10.0 | 10.3 | 10.3 | 10.2 | 10.2 | 10.1 | 10.1 | 10.1 |
| | 17 | | | | | 10.2 | 10.3 | 10.2 | 10.2 | 10.1 | 10.1 | 10.1 |
| | 18 | | | | | 10.2 | 10.2 | 10.1 | 10.1 | 10.0 | 10.1 | 10.1 |
| | 19 | | | | | 10.1 | 10.1 | 10.1 | 10.1 | 10.0 | 10.0 | 10.0 |
| | 20 | | | | | 10.0 | 10.0 | 10.0 | 10.0 | 9.9 | 9.9 | 9.9 |
| | 21 | | | | | 10.0 | 10.0 | 10.0 | 10.0 | 9.9 | 9.9 | 9.9 |
| | 22 | | | | | 10.0 | 10.0 | 10.0 | 10.0 | 9.9 | 9.9 | 9.9 |
| | 23 | | | | | 10.0 | 10.0 | 10.0 | 9.9 | 9.9 | 9.9 | 9.9 |
| | 24 | | | | | | 10.0 | 10.0 | 10.0 | 9.8 | 9.9 | 9.9 |
| | 25 | | | | | | 10.0 | 9.9 | 9.9 | 9.8 | 9.8 | 9.8 |
| | 26 | | | | | | 9.9 | 9.9 | 9.9 | 9.7 | 9.8 | 9.8 |
| | 27 | | | | | | 9.9 | 9.9 | 9.7 | 9.6 | 9.7 | 9.8 |
| | 28 | | | | | | | 9.9 | 9.7 | 9.6 | 9.7 | 9.8 |
| | 29 | | | | | | | | 9.7 | 9.5 | 9.7 | 9.8 |
| | 30 | | | | | | | | 9.6 | 9.4 | 9.6 | 9.7 |
| | 31 | | | | | | | | | 9.4 | 9.6 | 9.7 |
| | 32 | | | | | | | | | 9.4 | 9.6 | 9.7 |
| | 33 | | | | | | | | | 9.4 | 9.5 | 9.6 |
| | 34 | | | | | | | | | | 9.5 | 9.6 |
| | 35 | | | | | | | | | | 9.5 | 9.5 |
| | 36 | | | | | | | | | | 9.3 | 9.4 |
| | 37 | | | | | | | | | | | 9.3 |
| | 38 | | | | | | | | | | | 9.3 |

POOR

QUALITY

ORIGINAL